NATURE

No. 4158 SATURDAY, JULY 9, 1949 Vol. 164

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Telephone Number: Whitehall 8831
Telegrams: Phusis Lesquare London
Advertisements should be addressed to
T. G. Scott & Son, Ltd., Talbot House, 9 Arundel Street, London, W.C.2
Telephone: Temple Bar 1942
The annual subscription rate is £4 10 0, payable in advance, Inland or Abroad

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LOCAL ADMINISTRATION AND PROFESSIONAL KNOWLEDGE

UNDER the title "Can Communities be Planned ?", Political and Economic Planning has issued a broadsheet (*Planning* No. 296) which discusses from a different angle the question of local democracy which had already been the subject of some earlier broadsheets. Following its studies of the local devolution of responsibility in housing and education, P E P in Broadsheet No. 294 on "Agricultural Executives", reviewed the interesting experiment in the blending of local knowledge and experience with the central control of an industry which is also a way of life that the county agricultural executive committees represent. These committees are almost entirely independent of the county councils, and the P E P survey suggests that in most areas their standing in their own areas is as high, if not higher, than that of elected councils, and that they have inherited the goodwill of their predecessors, the war committees.

A county agricultural executive committee is a single-purpose body and commands respect because its members are accepted as leading men connected with agriculture. P E P points out rightly that a final assessment of the organisation must partly depend on the view taken of the social context of its work; if agriculture is a way of life in which the whole local community is concerned, there is some reason for basing its administration on local election and for bringing into it the more varied outlook and experience of county council members. Officially, the committees have been regarded as primarily concerned with carrying out Government policy, interpreted with specialist local knowledge; and while, by statute, some members have to be nominated by particular organised interests, Ministerial policy has been to stress rather the loyalty of such members to the committee and so to the Ministry.

The county agricultural officers and other officials who serve the committees are answerable to the Ministry of Agriculture and Fisheries, and that there is in practice very little friction may be due less to the very strong position of the Minister than to mutual common sense and tact and to the clear recognition that the committee's job is to interpret Government policy. So long as the local authorities are recognized as more independent in function, the agricultural executive committees are doing a different job, and P E P concludes that they do not, therefore, indicate a workable alternative to the election of local councils. They may be nearer to the specialist committees set up in other fields, frequently at Government request, by professional associations; indeed, the analogy may be closer, because while such professional committees will almost invariably have purely advisory functions, in practice the agricultural executive committees have rarely used their great disciplinary powers.

From the point of view of relating knowledge to action, the agricultural executive committees do not appear to have made any startling contribution to one of our greatest problems. *Planning* questions whether the Minister secures in this way a better

type of member than would be thrown up by election. The proportion of county councillors not only serving but also acting as chairmen of the committees suggests that to a notable extent the Minister falls back on men who are prominent in the local government of the county. Moreover, he appears to encounter the same kind of difficulties that are so painfully familiar in local government. Just as young men making their way in industry or the professions find it difficult to give time to public service, so small farmers are not easily persuaded to accept nomination to an agricultural executive committee; or, as P E P pertinently observes, no monetary payment will compensate the small farmer or rising professional man for not being available in his job at critical moments.

Judged, therefore, as an attempt to link knowledge with power, and to enlist local support and understanding in Government policy, the county agricultural executive committees appear to have but limited scope. So far as they have succeeded, it is due partly to the development of professional pride and satisfaction in seeing that a professional job is properly done, and partly to the recognition of this by the community. Both the professional and the social ideal must be served and find expression in unmistakable service to the community.

It is equally important that some fraction of the community finds expression for its sense of public service in doing such work, and to this aspect the later broadsheet addresses itself. The importance of organised activities in a local community can be exaggerated: there must be room for spontaneity. The planner must also remember that local communities are not the only social relationship open to people in a modern society. A good community is easier to recognize than to define. It is certainly not reflected only in the organised activities of what at the best is a minority of the population. A good community probably does find expression in vigorous clubs and associations; but it does not necessarily follow that fostering these activities will make a good community. Other influences such as kinship and common employment are also important.

When that has been said, the broadsheet urges that some types of community organisation will do more than others to bring people together, to overcome shyness and to arouse civic responsibility. Even if they affect only a minority, that minority can set the tone for the whole. Moreover, these types are not necessarily the most closely knit organisations, nor those with most explicit feeling for the community. When exiles think of their home town, they are as likely to recall the 'pub', the 'snack-bar' or Sunday evenings in the park as they are to think of the church, the school or the community centre.

The broadsheet presents a fair and well-balanced picture of the pros and cons of local communities: it deals with the argument that, in trying to revive community life based on place, planners are moving against the tide of popular desire, because with modern communications there is no need for people to focus their interests on a particular locality; and also with the counter-argument of Mr. Lewis Mumford, Dr. Elton Mayo and others that small groups are necessary for the preservation of individuality and human freedom in modern society. "Small groups, small communities; institutions framed to the human scale are essential to purposive behaviour in human society." Responsible citizenship is founded on groups of people small enough for them to know one another and to understand their common interests. "Good planning, in the post-war age," wrote Mumford, "will rest on the solid foundation of the family and the region; it will emphasize the biological and the social needs of the people, and it will treat the industrial and financial needs as subordinate ones." It might be added that such planning will respect the individual and the family in the township of 60,000 or more no less than in the village community of 600. The broadsheet takes reasonable heed of this requirement when it concludes that the task of the planner is primarily to leave room to move, so that communal activities are not distorted by lack of meeting-places. There are no predetermined answers to countless questions regarding the particular forms taken by these activities, and it is because there are as many answers as there are communities that local life maintains its quality and its variety.

Nevertheless, if local life maintains its vigour, the same cannot be said of local government. A year ago, the Local Government Boundary Commission declared that in most parts of Great Britain "our present powers and instructions do not permit the formation of local government units as effective and convenient as in our own opinion they should be". All, in fact, are now agreed that the structure of local government has not kept pace with the vast social changes of the past thirty years, that this failure is imperilling local democracy, and that comprehensive reform is now urgent. The Government has now announced that the Commission is to be wound up. Thus the structure of local administration is left untouched, although its powers and duties have been modified to the extent of well-nigh precipitating a crisis.

To this aspect of communal life the *Planning* broadsheets give little or no attention. One of the greatest values of the group or small community, whether its ties are local, cultural or professional, is the opportunity it offers for training in self-government and in responsibility. The greatest danger in planning is that this need for self-government, and for the preservation, indeed for the reinforcement, of the smaller and most intimate organs of local government, will be overlooked. It cannot be held that the present Government, in spite of its zeal for the good government of particular services, has been alive to this danger. Indeed, by steadily denuding the smaller authorities of virtually all interesting work except housing, it has encouraged the tendency to decay; no positive step has been taken to foster the vital element of self-government.

There is difference of opinion about the best means of encouraging local self-government. The method by which the basic conflict between county and town government, or between central and local government, is resolved matters less than that a term

should be put speedily to that conflict, and the choice of method should be made quickly. Moreover, there is another factor which is largely untouched in the *Planning* broadsheets—the question of publicity. It is true that P E P recognizes that the county agricultural executive committees are of value chiefly as a fair and human means of interpreting official plans and policy to the farming community. If due account is to be taken of the human factor in any organisation, however, the Government, whether central or local, or the management of an industry or public concern, must make a real effort to explain what is being done to those affected, and conversely to understand the mind and desires of all the citizens or employees.

Publicity and public relations are terms which are often abused and misunderstood, yet they are vital functions in a democratic society, both in local and in national affairs. Mr. J. H. Brebner, in a recent paper*, has done a real service by explaining so clearly what public relations and publicity can mean at their best, and how they can contribute to inspire people to think and act finely and generously in a common cause. In his paper, too, are hints on fostering a sense of community and purpose; like the *Planning* broadsheets, it will stimulate constructive speaking.

All these papers should contribute something towards rousing public opinion to a point at which the central Government will yet be made to face the problems of local democracy and local government, and the effective functioning of a democratic system. This would be an essential step towards solving the further problem of the relation of power and knowledge, and the place of the expert in the service of the community, which grows ever more urgent as the complexity of modern life increases.

* "Public Relations and Publicity." By J. H. Brebner. Pp. 44. (London: National Council of Social Service, for the Institute of Public Administration, 1949.) 2*s*.

MODERN COLLOID CHEMISTRY

Colloid Science

By A. E. Alexander and P. Johnson. Vol. 1. Pp. xxii+554. Vol. 2. Pp. viii+555–838. (Oxford: Clarendon Press; London: Oxford University Press, 1949.) 2 vols., 60*s*. net.

IN this monograph the authors have given a survey of a very wide field. Colloid systems play an important part in our daily life; in the organisms of all living plants and animals these systems are fundamental, and in the industrial manufacture of foodstuffs, clothes and so on, the colloid properties of matter are one of the corner-stones on which such a production has to be founded. Evidently, knowledge about the behaviour of colloid systems is of outstanding importance to many categories of people. Therefore it is very pleasant to find that a monograph has appeared in which a description is given of the experimental methods used in colloid science and in which colloid systems are discussed from modern points of view.

The book is divided in three parts: parts 1 and 2 are contained in vol. 1, and part 3 in vol. 2. Part 1 has been written as a general introduction and begins with a historical review of the subject. At the same time the principal advances are outlined. The year 1910 has been chosen as a border-line because it marks the end of classical colloid chemistry. At this time, colloid science was considerably influenced by the new advances in physics and chemistry. Furthermore, during the earlier part of this period, modern apparatus such as the ultracentrifuge, electrophoresis, etc., were designed. These powerful tools in the hands of eminent scientific workers have made possible the remarkable development of colloid science during the last decades. A discussion of the modern views of the colloid state is followed by a short survey of thermodynamics and by a thorough discussion of its applications to different colloid problems: osmotic pressure, Donnan equilibria, sedimentation equilibrium, vapour pressure and solubility, polymer-solvent systems, and mechanical properties of polymers. The last chapter is devoted to a critical discussion of the application of the Debye–Hückel theory to colloid systems. The stability of lyophobic colloids is outlined on the basis of Verwey's theory, and, finally, the part played by solvation as to the stability of lyophilic colloids is mentioned.

The experimental methods and apparatus used in research work on colloid systems are described in part 2. A subdivision into two sections has been made. Section *A* deals with systems as a whole and section *B* with interfaces. The main principles followed are to give the theoretical basis for each method, to describe the apparatus used and the measuring technique, and finally to show some examples of the utility of the methods. The first chapter in section *A* is an introduction, where the type of information necessary for a complete characterization of the colloidal particle is stated. It also contains descriptions of such methods as trace element analysis, combining weights and end-group analysis. Colligative methods are briefly mentioned. The partial specific volume factor and solvation measurements are discussed. Then separate chapters are devoted to osmotic pressure and membrane phenomena, sedimentation equilibrium, translation diffusion, sedimentation velocity, electrophoresis, viscosity and rotational diffusion. Optical methods, the application of X-rays and electron-diffraction are discussed. Finally, the phenomena of plastic flow and elasticity are briefly outlined. The methods are thoroughly treated, and their advantages and disadvantages are clearly pointed out. The study of interfaces in section *B* covers insoluble monolayers, adsorbed films and the solid/liquid interface.

In part 3 the principal colloidal systems are treated. Thus the methods of preparation, the structure, the stability and the more important properties are discussed for sols, gels and pastes, foams, emulsions, colloidal electrolytes, clays and zeolites, proteins and polymers. The last chapter is devoted to membranes. In four appendixes Einstein's relation between mean displacement and diffusion coefficient, the preparation and denitration of cellulose nitrate membranes, and dimensions of viscometers are treated. Finally, a subject index has been included.

The general impression made by this book is very good, and what can be criticized is often very much a matter of personal taste. The reviewer finds it unfortunate that it has taken almost two years to print this work. In the meantime a lot of valuable scientific

contributions have been made, especially in the field of high polymers, and, also, the fractionation of proteins started during the War has thrown new light on many problems. Much of this work is already summarized in special "Advances" and reviews. The value of the present monograph, however, could have been considerably enhanced if the authors had completed the references at the end of each chapter with more recent literature. In many cases these references are not very well selected. A few examples can be mentioned. A work of Snellman and Björnståhl (University of Uppsala) about streaming birefringence was published in 1941 in *Kolloid-Zeitschrift*. This work is of great interest from a theoretical point of view. Furthermore, many papers about the statistical treatment of chain molecules have appeared since 1934, when Guth, Mark and Kuhn published their papers. Williams *et al.* (University of Wisconsin) treated in 1946 the difficulties associated with the non-ideal behaviour of high-polymer solutions in sedimentation equilibrium. In this connexion it may be remarked that Table 11.1, "Molecular Constants of Proteins", could easily have been revised with respect to re-determinations which have been done since 1940.

To the reviewer the discussion of the colloid state in chapter 3 is rather confusing. The way in which the properties of matter are affected by the subdivision is important, a discussion of molecular weight averages is necessary, and so on; but none of these questions gives a modern view of the colloid state. Therefore, it would have been better to omit this chapter and to include its content elsewhere in the book. When the authors in chapter 8 state that definite information about pauci- and polydisperse systems cannot be obtained by means of sedimentation equilibrium, the reviewer does not agree. To the reviewer, M_w- and M_z-values are very good information. No method is universal, and this is a statement which applies to colloid science as well as to any other. In connexion with sedimentation velocity the authors should have introduced the unit S for the sedimentation constant ($1\ S = 10^{-13}$ c.g.s. units). In part 3 it seems a little confusing to discuss sols in a whole chapter, when the definition of a sol is given first in the next chapter. Most of the chapters in this part are very concentrated, and the treatment of proteins, especially, could have been more complete. Among the carbohydrates, polyuronides are not mentioned. During the last five years these substances have been studied from a colloidal aspect in many laboratories.

The reviewer has read the book with great pleasure, and many of the chapters are excellently written. Undoubtedly this work will be a very good first introduction to colloid science for students who are going to start their research work. It will also be useful to men of science and industrial research workers as a source of information about their actual problems and as a handbook where they can find orientations about purviews other than their own.

Interest in colloid science increased considerably during the war years. The development in the near future, certainly, will be very great. As the authors of this monograph point out, the expansion probably will proceed along both an industrial and a fundamental line; both are equal in importance. In conclusion, it can be said that the book really has given an illustrative exposition of the potentialities of colloid science.

P. O. KINELL

VELOCITY-MODULATION

Velocity-Modulated Thermionic Tubes

By A. H. W. Beck. (Modern Radio Technique Series.) Pp. x + 180. (Cambridge: At the University Press, 1948.) 15*s*. net.

VELOCITY-MODULATION is a term which came into general use only about ten years ago, denoting the process of periodically varying the velocity of a stream of electrons about a mean velocity. Unrecognized, or at least receiving little attention, this process has, however, been going on for a long time in all thermionic tubes in which the time of transit of electrons is comparable with the period of the oscillations present, such as Barkhausen-Kurz tubes, or magnetrons. The experiments of Clavier, Heil and Arsenieva-Heil, and Brüche and Recknagel in the middle thirties represent the first attempts to use this process deliberately for the purpose of generating oscillations at very high frequencies. Being in advance of their time, these attempts were, however, not really successful. Then, in the space of a few months (1938–39), there appeared a series of papers by American workers, notably Haeff, Hahn and Metcalf, Varian and Varian, Hansen and Webster, which transformed the situation. Velocity-modulation, velocity-variation, bunching, phase-focusing, or whatever the term used to denote the process, came forward as the method eminently suited to the frequency range—now called the microwave region—where frequencies are measured in thousands of megacycles, and wave-lengths in centimetres.

Three ideas were mainly responsible for the eventual success of the 'klystron', the prototype of all velocity-modulation tubes. First, the realization that at very high frequencies energy can be interchanged between electron streams and circuits *inductively*, that is to say, without electrons actually impinging on parts of the circuit. Secondly, at these frequencies certain forms of closed metallic cavities are very efficient in transferring energy to and from electron streams. Thirdly, transit-time, in allowing the velocity-modulated electron stream to drift and to form into bunches of increased charge-density, is a beneficial factor. The simultaneous realization of these three ideas was necessary, and sufficient, for the exploitation of the microwave region of the electromagnetic spectrum generally, while the invention of the cavity-magnetron by Boot and Randall enabled microwave radar to become the vital weapon of the Second World War.

Mr. A. H. W. Beck's book deals mainly with the klystron, and it does so very thoroughly from many aspects. It proceeds from simple first-order theory where the physical processes are plainly discerned to the more elaborate complete theory in gradual and logical steps. Thus the initial portions of the book will serve as an excellent guide to newcomers to this field, while the expert—designer and user of these tubes—will find here, for the first time collected together, a great deal of theory and design data which up to now could only be obtained from many scattered sources such as rare periodicals and unpublished reports. The chapters on heavy-current electron beams, signal-to-noise ratio in klystron amplifiers, de-bunching theory, the velocity-modulation mixer, and those dealing with the design and manufacture of power-klystrons are among those bound to be of particular interest to experts.

The book is well supplied with simple diagrams and very useful design curves. It is perhaps inevitable that there should be a host of symbols, and it is therefore a matter of some slight regret that more detailed information about the meaning of some of the symbols is not given in the list of symbols towards the end of the book. The book is certainly up to date; it is the only text-book so far to include a chapter on the theory of the travelling-wave tube, a recent development in the field of thermionic velocity-modulated tubes.

R. KOMPFNER

A FLAMINGO SAGA

Die Flamingos der Camargue

Von Etienne Gallet. Pp. 127 (56 plates). (Thun: Werner Krebser und Co., 1949.)

THIS book is remarkable for the excellence and variety of its photographs, and for the artistry and vividness of the writing. Etienne Gallet takes us to that strange country, the Camargue, a country where, as he puts it, sea and land meet and wrestle, and ever-changing salt is everywhere—a land of sand-dunes, swamps, meres, lagoons, mud-flats. It is a salt desert, and its vegetation is scanty and marine. Here the flamingoes arrive in spring to nest; but some remain throughout the winter.

The appearance of the flamingo is described on p. 28. The peculiar tongue, adapted to the beak, can move only backwards and forwards, not sideways; this tongue was a delicacy with the Romans. The life and behaviour of these stately birds is described vividly on pp. 41–47. They swim with head erect. When they alight on the water after flying, they stiffen out. They rise from the water in groups and fly either in wedge formation or in single file. When they are moving through the air in wedge formation, they change leaders continually. They give a trumpet call, like geese.

A careful account of the flamingoes' feeding is given on p. 44. They strain their food through their beaks like duck. They stand, almost motionless, in the mud or wet sand, rocking on their long legs, working their long necks, and, scooping up mud in a circle round them, they sift out the sand and throw it under them until it rises like a round table inside a hollowed-out, circular trench. Apparently they live on the mud itself—mud which contains dead and decayed organic matter; this they filter through their beaks. Although this apparently lifeless mud forms their chief nourishment, they may also eat grain, insects and algæ. They can live in regions where all other birds would die. The sand tables referred to above are round mounds, above, or just below, the water-surface.

Courtship and family life are described on pp. 47–48. Courtship begins in April with a wild dance of the males, while the females, in crouching attitudes which call to mind lotus flowers, watch the dance. Both birds brood the single egg. When this is hatched, the young bird is fed on a liquid resembling water for about two months. The young, when they leave the nest, as they do in the downy stage, form into age-groups to which they adhere strictly. In colour they are silver-grey to white, with silky down. Their beaks are straight and their legs pink.

After the first down has been lost, all the birds of every age-group join together. The second down is darker and woollier than the first. As the nesting season progresses, the weather often becomes hot and dry, the meres dry up, leaving the ground covered with salt. All other birds leave; but the flamingoes remain, trampling the mud and obtaining nourishment from it. When full-fledged, the young leave the dried-up lagoon for Vaccarès, where more food is to be had. The smell of the now deserted breeding grounds is beyond description; but the winter storms purify the nesting site before the arrival of another spring.

The book is full of beautiful descriptions of the scenery and of the birds, and is a fascinating work; the reader seems to live with the flamingoes. The preface is by Prof. Hediger, director of the zoological gardens at Basle. It is a translation from the original French into German.

SETON GORDON

SOUTHERN RHODESIAN ARCHÆOLOGY

The Prehistory of Southern Rhodesia

An Account of the Progress of Research from 1900 to 1946. By Neville Jones. (Museum Memoir No. 2, published for the Trustees of the National Museum of Southern Rhodesia.) Pp. 78. (Cambridge: At the University Press, 1949.) 7*s.* 6*d.* net.

IT is now some twenty-three years since the author's "The Stone Age in Rhodesia" appeared, and much has been learnt since those far-off days. It is good news to find that Mr. Neville Jones has brought matters up to date by publishing this new work on Southern Rhodesian archæology. The region is of especial interest to all concerned with the early story of the sub-continent because many of the migratory movements southward had necessarily to pass through the country and can be well studied there. Farther to the south the incoming folk fanned out and the movements tended to slow up, so allowing for admixtures of cultures to develop. The Wilton of the Cape, for example, gives one the impression of being much more sophisticated and influenced by its surroundings than does the same culture in Southern Rhodesia.

After a historical introduction, the author devotes a chapter to the pebble-tool cultures, the earliest known in the region. A great deal has been learnt about these pebble industries in the last twenty years or so. A long chapter on the subsequent stone-age cultures comes next, and this in turn is followed by an account of some excavations in cave sites—especially at Bambata, where the author is not entirely in accord with Mr. Leslie Armstrong's observations of 1929. Rock paintings are next considered, and the book ends with chapters dealing with the special problems of the ironstone kopjes' cultures and a general conclusion.

Mr. Neville Jones has had to keep both the general public and the specialist in mind. The book is intended not only to bring the prehistory of Southern Rhodesia up to date, but also as a museum memoir to enable the inhabitants of that lovely country to take an intelligent interest in the remote past of their land. A glossary of technical terms is added, and there are many illustrations both of stone tools and of rock paintings. A useful map of sites and a bibliography are also appended. It is certainly a work to possess, and all students of South African prehistory will be grateful to Mr. Neville Jones.

MILES C. BURKITT

The Naming of the Telescope

By Edward Rosen. Pp. xvi + 110 + 5 plates. (New York: Henry Schuman, 1947.) 2.50 dollars.

DR. E. ROSEN has written a remarkably lively little book, the conclusion of which is that the term 'telescope' was originally devised by John Demisiani of Cephalonia, and made public by Frederick Cesi at the banquet given in honour of Galileo on April 14, 1611. The circumstances may seem to the man of science of to-day to be too minute to warrant the publication of a book; but we must welcome here what the history of science so notably lacks, namely, a painstaking and detailed inquiry into a doubtful point concerning which both contemporaries and historians are at variance. The book scarcely needs to justify itself by its subject-matter, for such is the gusto of its author that the reader is infected by that strange passion that keeps sensible men out of bed after midnight to read detective stories.

The book is accurate and scholarly as well as lively, though the reviewer confesses a shudder at the statement that Frederick Cesi, Theophilus Müller and Henry Corvinus "hiked from the castle of the illustrious marquis at St. Polo to lofty Mt. Gennaro". Let us have a translation either into English or American, not a macaronic of the two, as inappropriate as the vision which it conjures up of Cesi in short pants.

The last section of the book glances at a few of the terms other than *telescopium* used for this instrument; such a study might, indeed, have been carried further, and would have revealed some interesting usages. Thus, Henry More speaks of a "Galileo's tube", and Henry Vaughan gives two other synonyms in a well-known verse, which affords one of the few examples of successful scientific simile:

> Either disperse these mists, which blot and fill
> My perspective still as they pass;
> Or else remove me hence unto that hill,
> Where I shall need no glass.

F. SHERWOOD TAYLOR

Reagents for Qualitative Inorganic Analysis

Editors: P. E. Wenger and R. Duckert; Joint-Authors: C. J. Van Nieuwenburg and J. Gillis. (Second Report of the International Committee on New Analytical Reactions and Reagents of the International Union of Chemistry.) Pp. xxii + 379. (New York and Amsterdam: Elsevier Publishing Co., Inc.; London: Cleaver-Hume Press, Ltd., 1948.) 39*s*. 6*d*.

REAGENTS for the identification of inorganic radicals have been proposed in profusion; on the other hand, published descriptions often lack information on their limitations. The International Committee on New Analytical Reactions and Reagents of the International Union of Chemistry, in its report of 1938, made a selection of reagents for study to which have been added any offering promise that appeared afterwards. Despite the difficulties of the times, the Committee was ready in 1943 to consider publication, but it was not until 1945 that the "Deuxième Rapport" appeared; some additions, in particular a selection of photomicrographs, have been made for the present English text.

Only reagents commonly available or readily prepared have been considered; in the latter case, brief preparative details are given. Where there are very many possibilities for any one ion, about half a dozen have been chosen. The general arrangement is simple: first, a statement of the mechanism of reaction (if known or presumed), then details of the test (which may be under the microscope, on spot-plate, on paper or in test-tube, micro- or macro-), and, finally, limitations of sensitivity and selectivity. These last are the most important features of the work, for it is essential to know if and how the presence of other substances affect the delicacy of a test. Group separations are described separately.

Here, then, we have an unbiased and critical selection and survey of a large number of qualitative reactions; the value of this work needs no stressing. The style of production is generous by our standards; an extensive bibliography is included. Very occasionally, phraseology is rather quaint, but not so as to obscure the meaning.

B. A. E.

New Song in a Strange Land

By Esther Warner. Pp. xi+302. (London: Victor Gollancz, Ltd., 1949.) 16*s*. net.

THE strange land which inspired this new song is Liberia; but anyone who reads this book to find out something about that country is unlikely to be much wiser by the time he has finished than when he began. Nearly all Mrs. Warner has to say has already been said about every other part of the west coast of Africa, from Dakar to the Cameroons. It is not a new song, but the old, old story, told for American readers. But one can forgive Mrs. Warner a lot, for she writes in the main about simple, ordinary folk who she clearly came to love, and although her rendering of the song is so melodramatic as to be almost nauseous in parts, it is redeemed by this obvious sympathy—but only just. Of the true Americo-Liberians, Mrs. Warner has little to say; but one is left with the impression that if one wishes to seek for exploitation and oppression on the west coast of Africa to-day, the most likely place to find it is not in the territories of the European Colonial powers but in this free republic administered by America's god-children. One or two of Jo Dendel's woodcuts are pleasing; the rest are so trifling that it is difficult to see why they were included.

J. O. FIELD

The Harold Whitaker Collection of County Atlases, Road-Books and Maps presented to the University of Leeds

A Catalogue by Dr. Harold Whitaker. Pp. 143. (Leeds: Brotherton Library, The University, 1947.) 10*s*. 6*d*.

THIS catalogue of the private collection of Dr. Harold Whitaker is invaluable not only as a model of its kind—in which it follows the methods already adopted by the author in his similar works on Yorkshire, Lancashire and Cheshire—but also as illustrating the development of cartography, more particularly in England, from the sixteenth to the nineteenth centuries. It records some maps not already noticed in standard works, includes one item not previously known, and has, in addition to the main catalogue, brief appendixes on road books, maps of Yorkshire and general atlases. There are a number of black-and-white illustrations. Dr. Whitaker has generously given the whole collection to the University of Leeds, the librarian of which contributes an introduction to this excellent work.

J. N. L. B.

INFLUENCE OF PHYSICAL THEORY ON BIOLOGICAL THOUGHT*

By Dr. A. TINDELL HOPWOOD
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THE phrase "physics is the fundamental science" is both familiar and true. Every special science presupposes physics; but the physics of a generation or so earlier. This essay is an attempt to relate biological thought at certain periods of European history to the physical theory then in vogue. So far as possible, metaphysics have been excluded; but it must be borne in mind that an examination of the basis of any science cannot be made without going outside the boundaries of that science, and that the examination must be in terms which, however severely scientific they may be in themselves, are, none the less, metaphysical from the point of view of the science examined.

Science itself is the study of the sensible, or observable, universe; it is concerned only with that part of the totality of facts which is observable, and is unable to affirm or deny the existence of facts which it cannot observe. Consequently, science cannot study the thing in itself, but only the manner in which the thing behaves. As Whitehead put it, "For physics the thing itself is what it does. . . ."

Exactly the same is true of biology. To describe phenomena in terms of genes is not to explain the causation of those phenomena; it is to relate two phenomena, each to the other, and to state a probability that when one is observed the other also will be observed. That is, what purports to be an explanation is really an analysis of certain aspects of the organism's behaviour.

This parallel between physics and biology was unknown to the Greeks, to whom biology was an unimportant branch of physics, and whose picture of the sensible universe was completely different from ours. They thought of Nature as something material extended through Euclidean space. It was in spontaneous motion, therefore it was alive and possessed *psyche*, or soul, and because its motion was orderly it also possessed mind. Plato explained change as a function of structure; he was a geometer, whereas Aristotle, the biologist, explained it as the result of a *nisus*, or urge from within. The latter explanation allows of change in a definite direction, and might be taken to conceal the germ of an evolutionary theory, despite the fact that Aristotle held it to be "absurd to make the universe to be in process of change because of small and trifling changes on earth". But the Greeks, who thought of time as a succession of instants, were unable to account for continuous motion, and Aristotle's comment that a given amount of motion requires a given amount of time in which to develop, although it anticipated the teaching of modern physics, did nothing to remove the difficulty, which is inherent in discrete space and time.

The physical background of Aristotle's thought put him on the track of an evolutionary doctrine; but it also deprived him of the means whereby the doctrine could be brought to fruition.

After the close of the Hellenistic period, science made no further progress until the Renaissance; then it was re-established upon new foundations during the seventeenth and eighteenth centuries by Galileo, Descartes, Newton, Ray and Linnæus. Galileo and Descartes expelled the *psyche* from the universe and left Newton to explain the phenomena of a dead world. Nature was no longer alive, intelligent, and extended through space; but composed of a multitude of particles of dead matter scattered in empty space. When the particles moved, their motion was to be ascribed either to the action of gravitational forces or else to the result of impact. In each case, motion was imposed from without; it no longer arose from within.

Such a universe provides no challenge to the idea of fixity of species. The essence of a dead Nature is that it is immutable except for the influence of external agents. In combination with three-dimensional space, and a separate time composed of a succession of instants, it provides an ideal physical background for the development of systems of classification, because every event is determinate and precisely located in space and time. Consequently one is not surprised to find that first Ray, and then Linnæus, busied themselves with naming plants and animals and arranging them in appropriate 'pigeon-holes'.

Physics and the sanctions of religion were united in making the development of an evolutionary philosophy all but impossible, and when, three-quarters of a century after Newton, an apostle of evolution arose in Lamarck, he was a free-thinker whose theory largely depended upon the action of external forces. This was the one type of evolution possible in a Newtonian universe; but men's minds had become so attuned to the idea of a fixed order of things that any suggestion of evolutionary progress was anathema, whether it accorded with physical theory or not.

There was little change in the general position until the publication of the "Origin of Species", which began the Darwinian interlude. From then until the turn of the century the predominating influence over the minds of men was exercised by biology and not by physics. Doubtless the novelty of the theme had much to do with it; but even more weight must be ascribed to the confusion which reigned in the physical sciences.

The universe, an improved model of the Newtonian universe, was a gigantic machine, which was slowly running down and would one day cease to function. Space, now filled with ether, was still three-dimensional, and time still a succession of instants. That is, space and matter were abstracted from time just as they had been in the days of Zeno. That abstraction, which underlay the physical presuppositions of the current taxonomy, was the cause of the curiously anomalous position of the doctrine of evolution, and there was then, as there still is, an unexpressed discontinuity at variance with the fashionable doctrine of a gradual upward progress from the unicellular state to the majesty of man. Moreover, the teachings of the special sciences were so often contradictory, the one of the other, that the study of Nature became completely unintelligible.

* Substance of a paper read before the Linnean Society of London, May 12. For permission to publish this abridgment I am indebted to the kindness of the President and Council. The full paper will appear in *Proc. Linn. Soc.*, **161**, pt. 2.

Apart from the fact that the existence of a machine necessarily implies an external maker, and the men of science were making an unwarrantable excursion into metaphysics in discussing the point as men of science, the machine itself resembled no other machine in that it was self-improving, self-renewing, and, at the same time, slowly running down as its entropy increased. In addition, the machine was looked upon as a mere aggregate of its parts, a fallacy which still lingers in some quarters.

Many of the difficulties arose from the separation of life from matter. There was a threefold struggle between physics, chemistry and life. The elementary particle presupposed by physics was devoid of mass, whereas the chemist presupposed a variety of elementary particles, each with its own appropriate mass. Somehow or other the interaction of these incompatibles was manifested as life; but the manner of their interaction was obscure.

One consequence of the confusion in the sciences presupposed by biology was that biology itself was confused. Taxonomy continued to develop on its age-old basis of an analysis of the characters of dead individuals, and was unable to progress except by way of correction and amplification of what had gone before. Evolution being a continuous process, *ex hypothesi*, could not be expressed by orthodox taxonomy, but found separate expression in phylogenetic trees.

Nevertheless, the many disadvantages issuant from the underlying confusion were not without their compensations. Classical physics possesses the merit that it enables us to think of Nature-at-an-instant. Indeed, to separate time from space is the only way in which this can be done, because Euclidean geometry disappears in the four-dimensional space-time continuum. When it reappears, in ten dimensions, independent time does not reappear because it is still the fourth dimension. Hence, classical physics and classical taxonomy march forward together, but an evolutionary biology presupposes an evolutionary physics, and during the Darwinian interlude that still lay in the future.

Whitehead made some caustic remarks about this period, saying that "in its last twenty years the century closed with one of the dullest stages of thought since the days of the First Crusade. . . . The period was efficient, dull and half-hearted."

Although it was dull, it certainly was not dead. It was the most important half-century since the Renaissance; it prepared the way for the replacement of a static by a dynamic universe, and for the integration of space and time.

Modern physics may be taken to begin with the recognition of the compound structure of the atom. That the original model of the 'solar system' atom is in some ways out of date is of no great importance. The significant factors are the replacement of inertia by movement, and of mass by energy. Together with the concept of a space-time continuum, these two new ideas remove the old antagonisms between the physical and biological sciences, and offer a universe which allows of continuous motion in any direction, a universe in which evolution can take place, and in which one would predict that it must take place.

In this modern universe the word motion becomes ambiguous, for there is not one kind of motion but two. There is the motion which involves duration and a change of position, and there is the motion which involves duration but no change of position. The first type we will call locomotion, and we will restrict the use of motion to the second type. Of these two types, locomotion is the more important as a biological presupposition, because it is the physical expression of change, and so the counterpart of evolution in biology. Motion, on the other hand, is the expression of maintenance. It represents the expenditure of energy in the preservation of identity, whether the identity be that of a physical or of a biological unit.

There is a certain indefiniteness about the behaviour pattern of a particle in locomotion which has been formulated in Heisenberg's Uncertainty Principle. In its most generalized form, namely, that the more accurately the velocity of a particle in locomotion is determined the less is known about its position, and conversely, the principle of uncertainty is also applicable to living Nature. When an organism is in locomotion, in other words, when it is in process of evolution, the biologist may either concentrate on its velocity, which is its evolutionary history, or he may concentrate on its position, which is the stage of evolution it has attained, but he cannot concentrate on both of them at once.

In either instance the picture will never be entirely sharp. Complete concentration on the velocity is not possible; if it were, the organism would lose its identity. Complete concentration on the position is also impossible because the velocity cannot be entirely ignored. A species comprises, not only the individuals now living, but also an indefinite number of generations that have lived, as well as an indefinite number that will live. These past and future generations are the expression of that part of the velocity which cannot be ignored.

The behaviour pattern of an organism in motion is analogous to, but not the same as, the behaviour pattern of an organism in locomotion. The difference between them is that the former is engaged in maintaining, and the latter in losing, its identity, whereas the analogy arises from the fact that each in its own way is engaged in a process of becoming. Throughout the whole of its life-history, the organism retains its identity in the narrow sense that John Smith remains John Smith from the cradle to the grave; on the other hand, the life-cycle is a continuous, uninterrupted process with no sharp divisions between its different stages. There is an uncertainty attendant on the motion of an organism, precisely as there is an uncertainty attendant on its locomotion. The principle is the same but it is applied to different entities.

At this stage it is evident that use of the word organism without qualification involves some ambiguity. The difficulty arises from the fact that the phrase 'organism in locomotion' suggests a species, whereas 'organism in motion' suggests one of the individuals included within the species. Nevertheless, there is a sense in which the species is in motion, and the individual in locomotion. If it were not for the former, the species could not maintain its identity; but for the latter, the species could not change its identity. In this sense the use of organism to cover both the species and the individual does not appear to be a serious error; but confusion may be avoided by employing the terms 'species-organism' and 'unit-organism' when the sense requires them. The species-organism is more especially the concern of the palæontologist, who investigates its locomotion, whereas the unit-organism is the main concern of the neontologist, who investigates its motion. Each worker ignores the other at his peril; existing forms

of life cannot be interpreted except in terms of their past history, and the past must be studied in the light of the present.

Physical theory holds that space implies time; it needs time for development. Time, on the other hand, implies space; neither can exist without the other. Pattern is secondary to these primary phenomena; it must have both time and space in which to develop. Whitehead summed up the position in the famous phrase, "There is no Nature at an instant".

For more than two thousand years, naturalists have proceeded on the basis of an infinite three-dimensional space, which endured by the summation of a succession of instants. Now they are told that there is no Nature, alive or dead, at any given instant, that duration is essential to existence, that events can be precisely located neither in space nor in time, and that everything is in a state of movement or flux. In short, they have to adjust their ideas to an entirely different set of physical presuppositions.

Current taxonomy is founded on the old assumptions, and, so long as it is concerned with the position and motion of organisms, it continues to function fairly well, particularly when dealing with the present, or with apparently isolated events in the past. Difficulties arise when one attempts to fit organisms in locomotion into a framework which was not designed for their reception. The result is to distort either the component representing position or else that representing velocity.

The amount of distortion is largely dependent on the skill and judgment of the taxonomer; but it is always considerable. It is the result of an endeavour to discuss velocity in terms of position, and its effects are illustrated in Simpson's arrangement of the Equidæ. There the lineage which leads from *Hyracotherium* to *Equus* is divided among three subfamiliee, each containing a segment of the main stem as well as of one or more side branches. The classification is the fruit of great experience and mature judgment; but its author had no course open to him other than to represent a single biological entity of one kind under the guise of three entities of another kind. In effect, orthodox taxonomy emphasizes the static side of biology, and therefore fails to give adequate representation to the organism's velocity or evolution.

Osborn's formal classification of the Proboscidea is not generally accepted because, as he himself admitted, it differs more from all existing arrangements than these do from the Linnæan system. His method was to isolate as many ascending lineages as the evidence appeared to warrant, and to call each lineage a subfamily. Larger gaps in the record broke the lineages into larger sections or 'genera', and minor gaps broke up the 'genera' into 'species'; there are other complications of secondary importance.

The fundamental difference is that Osborn constructed the first classification of organisms in locomotion, and, although he does not appear to have been aware of the fact, the first classification at all conformable with the modern physical background of biology. For this reason the Osbornian principles are worthy of closer study than they have hitherto received, since they may foreshadow the taxonomy of the future. Evolutionary biology now has the evolutionary physical background it requires as a basic assumption, and sooner or later its primary discipline must adapt itself to the changed conditions.

THE GENERAL CIRCULATION OF THE ATMOSPHERE

ON May 18 a meeting of the Royal Meteorological Society was held to discuss the problem of the changing pattern of large-scale flow in the atmosphere, usually known as the 'general circulation'. In opening the discussion, Dr. E. T. Eady pointed out that even on a large scale, when the motion has been smoothed of such small-scale and transient irregularities as travelling depressions and anticyclones, fronts, etc., we were not concerned with a problem of steady motion; 5-day mean charts smooth out most of the travelling disturbances (including the 'long waves' which travel, on the average, nearly a complete wave-length during this period), but differ very considerably among themselves even for the same time of year. Only when we take means over a long period does the mean flow approximate to that shown on climatological charts. The general behaviour is reminiscent of small-scale turbulent motion (frictionally induced) in aerodynamics, means over longer and longer periods bringing out disturbances of longer and longer wave-length, finally yielding a quasi-steady mean flow. Although the mechanism by which large turbulent disturbances in the atmosphere are continually regenerated (to make up for frictional dissipation) differs from that by which small-scale aerodynamic turbulence is maintained, there is a broad similarity between the two types of turbulence. Just as in aerodynamics, we cannot divorce the study of the mean motion from that of the turbulent disturbances, since these are mutually determining.

In Dr. Eady's view, empirical evidence points to the necessity for adopting such an attitude. Calculations of the radiation balance in different latitudes, such as those carried out by Sir George Simpson, showed that there must be, on the average, a transport of heat from low to high latitudes. Since the upper troposphere shows a negative radiation balance, there must also be upward transport of heat. Although part of the former might be effected by ocean currents and part of the latter by small-scale convection, the main transport is probably associated with the large-scale disturbances, that is, it is eddy-transport. Only in limited regions can steady mean currents, such as the monsoon circulations, effect part of the transport. Besides poleward transport of heat, we also have poleward transport of westerly momentum; for the climatological charts show a belt of easterly winds in low latitudes, the 'trades', and westerly winds in middle latitudes, which have to be maintained against friction. This, acting alone, would eventually destroy the motion completely, and the persistence of these mean winds requires an effective transport of momentum which can only be brought about by disturbances, not by steady currents.

The poleward and upward transport of heat, that is, from a warm 'source' to a cold 'sink', is a thermodynamic necessity if solar radiant energy is to be transformed into kinetic energy to maintain the motion of the atmosphere against friction. The precise mechanism by which this transformation takes place is only just beginning to be understood. It is clear that if new disturbances are to develop from time to time we must show that the mean motion is unstable. Dr. Eady referred to a forthcoming paper of his in *Tellus* (1, No. 2, May 1949; Stockholm), in which it is shown that steady

uniform motion of a rotating baroclinic fluid, such as the atmosphere, is unstable in almost all circumstances, even when convectively stable. Previous attacks on the problem of dynamical instability when there are no velocity discontinuities (velocity discontinuity always gives rise to instability, at least on a small scale) have lacked generality. They discussed essentially 'overturning' in a vertical plane and obtained the well-known criterion, negative absolute vorticity in isentropic surfaces. But another type of disturbance exists, corresponding to 'overturning' in a plane sloping upwards toward the pole at an angle less than that of the isentropic surfaces. Long-wave disturbances are almost always unstable. In each case there exists one particular disturbance which grows faster than any other and becomes apparent on synoptic charts by a process analogous to 'natural selection'. The long waves observed are the form of breakdown, by this process, of the whole troposphere. Smaller secondary disturbances are the form of breakdown, by a similar process, of baroclinic cloud sheets, that is, 'frontal' regions. There is good numerical agreement between theory and observation regarding wave-length, wave-velocity, growth-rate, and structure of these disturbances. Dr. Eady concluded by discussing briefly some of the difficulties encountered in attempting to extend the theory to make possible the computation of weather changes (more precisely, of *most probable* changes), and also mentioned one way in which orography causes irregularity in the mean flow at all levels.

In the absence of Mr. C. H. B. Priestley, Dr. A. G. Forsdyke gave an account of his paper, "Heat Transport and Zonal Stress Between Latitudes" (*Quart. J. Roy. Met. Soc.*, **75**, 28; Jan. 1949). Mr. Priestley was concerned with estimating, from empirical evidence given by *radio-sonde* winds and temperatures, the actual poleward transport of heat and momentum referred to above. The flux of heat can conveniently be divided into (i) a component associated with the mean flow; (ii) a 'toroidal' (meridional) component associated with net poleward flow at low levels, equatorward flow at high levels; (iii) an eddy-flux associated with transient disturbances. Since for this purpose heat may be regarded as a conservative quantity, the eddy-flux of heat is proportional to the correlation between poleward motion and excess heat content. It is convenient to divide the latter into sensible heat (measured by temperature), and latent heat of water vapour. It would be desirable if this eddy-transport could be evaluated at a large number of stations, and it was one of Mr. Priestley's objects to set an example by computing it for one station, namely, Larkhill, England. He found that transport of heat in latent form is about the same as that in sensible form. He also noted a curious negative transport, that is, towards the equator, in the upper troposphere, while in the stratosphere the transport is towards the poles. He also computed the toroidal flux, but there appears to be some doubt (expressed by Mr. J. S. Sawyer and Dr. Eady) regarding the validity of his formula.

Momentum (or angular momentum) is not a conservative quantity for individual particles. Nevertheless, the total transport of momentum across a circle of latitude over all heights is given by Jeffreys's formula, which is, in fact, simply the total Reynolds's stress. Mr. Priestley evaluated separately components which can be regarded (formally) as eddy-flux and toroidal flux. The latter is considerably the smaller. He found that the total flux is in the right direction in winter, but much smaller and often negative in summer. On the whole, it is of about the right order of magnitude.

Mr. Priestley has not evaluated the transport associated with the mean flow. Evaluation at one station would be of little value, since on integration round a circle of latitude the contributions would largely cancel.

Dr. R. C. Sutcliffe gave an illustrated account of a preliminary attempt to sort out types of large-scale flow empirically. He suggested that the atmosphere can 'solve its own equations' in a variety of ways, yielding types of flow pattern which persist for considerable periods; from time to time it 'flips over' relatively quickly from one basic pattern to another. He did not indicate, however, why this takes place, except to suggest that it is associated with seasonal changes.

Sir David Brunt emphasized the importance of calculations such as those of Mr. Priestley. He referred to several early calculations, including those of Mr. E. Gold, indicating radiative cooling of the upper troposphere. He suggested that some meteorological problems cannot yet be solved because of ignorance regarding the correct boundary conditions. Mr. J. S. Sawyer emphasized the importance of travelling disturbances in determining the general circulation. Prof. P. A. Sheppard, referring to strong winds (and hence appreciable energy in spite of low density) in the upper stratosphere, indicated the possibility of events at these levels affecting the circulation below in the long run.

Mr. A. W. Brewer said that accurate humidity measurements, with the Dobson–Brewer frost-point hygrometer, suggest, on account of the extreme dryness of the stratosphere, that the troposphere and stratosphere are two different worlds. Measurements of helium content show no appreciable variation up to at least 22 km., so that there must be some diffusion across the tropopause; but it cannot be large or the very steep gradient of vapour content would be destroyed. He suggested that stratospheric air in middle latitudes originates above the tropopause in low latitudes, where even saturated air has very little vapour content. He indicated some of the difficulties involved in this theory, since it requires rather rapid radiative cooling in the air subsiding along the tropopause; further, if purely zonal flow is postulated, angular momentum should be conserved (contrary to observation) during transit.

In his concluding remarks Dr. Eady referred to the changes in the tropospheric motion to be expected if the mean stratospheric temperature changes, with consequent alteration in the mean height of the tropopause.

HETEROGENEOUS CATALYSIS

A DISCUSSION meeting of the Chemical Society held on March 17 was devoted to heterogeneous catalysis. Papers were read by Mr. D. A. Dowden and Dr. P. W. Reynolds, of Imperial Chemical Industries, Ltd., which outlined the work of the Billingham Division on a new approach to catalysis which was formulated in 1944 and first published in 1948 [1].

Many workers have stressed the importance of relationships between the dimensions of reacting molecules and the crystal parameters of the catalysts

which are active for their conversion. The point has been emphasized by the careful work of Beeck and his co-workers[2] on evaporated Group VIII metal films in ethylene hydrogenation. They found a five-fold greater activity for oriented nickel films than for random films, and they ascribed this difference to preferred spacings exposed in the oriented films. Following this indication, Beeck[3] related the activity of metal hydrogenation catalysts to their crystal parameters and demonstrated the predicted high activity of rhodium.

It seems certain that such spatial considerations must play their part; but even if the suggested geometrical relationships are necessary for high activity, they are certainly not sufficient. Copper, silver and gold, for example, have crystal parameters which would suggest a high activity, whereas, in fact, there is little or none. Moreover, it is always possible that these geometric correspondences are only incidental, and the prevalent tendency to hunt among the Miller indices for a plane with a promising spacing is viewed with suspicion. It has been the aim of the Billingham work to establish alternative correlations between the catalytic activity and physical structure of solids which may be more fundamental than these.

In the simplest example of hydrogenation over metallic catalysts, the activity of the Group VIII metals is attributed to the unfilled electron-levels in their 3*d*-, 4*d*- and 5*d*-bands. The relative inactivity of copper, silver and gold is thus explicable. It becomes of special interest to study the alloys of the Group VIII metals with these Group I *b* metals and with one another. The principal effort is being directed to the study of spectroscopically pure metallic foils; but results already obtained on industrial catalysts in the nickel–copper system give strong support to the theoretical picture. The system exhibits a continuous series of solid solutions; the lattice parameter–composition relationship does not depart appreciably from Végard's law. Beeck's correlation would suggest a steady increase in the activity of the nickel by the expansion of its lattice through the inclusion of copper. The electronic picture, on the other hand, would suggest a marked fall in the activity of nickel as the valency electrons of the Group I *b* metal fill up the holes in its 3*d*-band. In pure alloys at equilibrium, these holes are just filled up by 60 atomic per cent of copper. The ferromagnetic properties, as measured by the large magnetic susceptibility at a fixed field strength, disappear at the same composition. So also should the catalytic activity.

Alloy-skeletal catalysts, derived from copper–nickel–aluminium alloys by extraction with caustic soda, and reduced copper–nickel oxide on kieselguhr catalysts, have been examined in benzene and styrene hydrogenation. In both series there was a parallel decline in activity and magnetic susceptibility as the copper : nickel ratio increased, the values becoming very small at 30–40 atomic per cent of copper. The occurrence of the critical composition at a lower copper content than would have been expected from the properties of the pure alloys is undoubtedly due to the complexity of the catalysts in question; but these results do show that the catalytic activity and the number of holes in the *d*-band fall away together, and that they do this while the crystal parameter is increasing slightly in the direction of increased activity on the simple geometric view.

Catalysis must be preceded by chemisorption of the reactant, so that the catalyst crystallites may be considered as sources or sinks for the electrons transferred or exchanged in the ionic or covalent bonding which is involved. The electron band theory of solids, the classical ionic lattice theory and the rapidly expanding knowledge of defect structures enable these processes to be viewed with a new precision.

Provided that surface and volume diffusion steps are very fast, the rate-controlling step in a catalysed reaction must be either the chemisorption of a reactant, a reaction in the sorbed state, or the desorption of a product. The form of the free-energy curves representing these steps[4] is such that the free energy of activation is always lowered, other things being equal, by bringing the initial and final states close together in space, by reducing the free energy of the initial state, or by increasing that of the final state. An active centre would then appear as a region of special geometry which makes possible this proximity of initial and final states, and the free energy would correspond to the strength of the bonds with the surface. This bonding may be homopolar or heteropolar, but in either case appropriate levels of minimum energy must be found for the electrons exchanged or transferred at the interface when the atoms, radicals or ions are adsorbed.

Modern theory provides a detailed knowledge of these processes. Excluding surface states from consideration, the donation of an electron to the catalyst crystallite by an adsorbate, whatever the mechanism, must raise the energy of the Fermi surface and is equivalent to the addition of an electron to the lowest empty level. This process is easiest when there is only a small difference between the ionization potential of the particles at the surface (I') and the metal work function (φ), and when the density of levels at the Fermi surface is large. If the sorbate at the surface is considered to be a surface phase, the electrons of which are in equilibrium with those of the metal through a dilute electron gas, then the ratio of ionized to neutral species in the surface phase ($C_A{}^+/C_A$) is proportional to

$$\exp - (I' + \mu_e{}^M)/KT, \quad \text{where } I' = I - \Delta U^+,$$

and $$\mu_e{}^M = -\varphi - \tfrac{1}{3}\pi^2 K^2 T^2 (d \log_e g(\varepsilon)/d\varepsilon)_\varepsilon = -\varphi,$$

where $\mu_e{}^M$ is the thermodynamic potential per electron per unit volume, I is the ionization potential of the neutral particle *in vacuo*, $-\Delta U^+$ is the adsorption energy of the cation, $g(\varepsilon)$ is the density of electron levels per unit volume, and ε is the metal electron energy. In a given system $|\Delta U^+|$ is a maximum (and I' a minimum) when the ion has acquired the greatest number of lattice atom nearest neighbours, so that the active centre is a position where the ion can be located interstitially at the surface, or occupy, as closely as possible, a vacant lattice point at the surface. The Helmholtz free-energy of activation for ionization at such a centre is given by:

$$\Delta F^* \propto I + \mu_e{}^M - \text{constant} \times \Delta U^+,$$

and the factors which contribute to a large surface concentration of cations also increase the rate of cation formation.

If it be assumed for simplicity that the forces contributing to ΔU^+ are Coulombic (image) forces and practically independent of the metal, then positive ion formation is most favoured and fastest on metals and alloys exhibiting a large electron exit work function and a large positive value of ($d \log_e g(\varepsilon)/d\varepsilon$) at the Fermi surface. It will be favoured also by crystallization in a manner which exposes

the planes of least dense packing, or more densely packed planes with a high concentration of vacant sites, and by the addition of traces of electronegative substances. The data available suggest that the requisite metallic properties are to be found in metals and alloys having holes at the top of the *d*- or *f*-bands. (When both the cation radius and *I* are large, as with some saturated molecules, ionization may more easily occur indirectly by electron transfer with some more easily formed cation, for example, H^+.)

By similar reasoning it is demonstrable that negative ion formation requires the same geometry for the active centre, but a small electron exit work function and a large negative value of $(d \log_e g(\varepsilon)/d\varepsilon)$ at the Fermi surface. It will be promoted by traces of electropositive additions.

The concentration and rate of formation of a covalently bonded species depend similarly on the bond strength. Pauling's older concepts[5] show that the bond strength decreases as the *d*-orbital content of the hybridized orbitals diminishes, whereas according to his later scheme[6] the number of empty 'atomic' orbitals drops to zero as the *d*-band is filled. The number of unused surface 'bonding' orbitals continues to fall as more *s*-electrons are added to the metal. Since these orbitals are required for occupation by electrons in the process of chemisorption, a rapid fall in activity occurs at the alloy composition where the *d*-band is filled, followed by a much slower decline with further increase in the electron : atom ratio. The band theory of metals leads to the same conclusion, since the number of canonical forms of low excitation energy of the chemisorbed complex must increase with increasing electron-level density, leading to enhanced resonance energy and greater bond strength. As entropy can be put proportional to the logarithm of level density, it is suggested that the entropy of activation decreases as bands of high level density are filled. Real chemisorptive bonds involve Coulomb forces, exchange forces and Van der Waals forces, and it is convenient that when the mixed bond involves a tendency to positive ion formation, all three vary in the same way with the properties of the *d*-band holes.

These relationships between the electronic structure of the solid and the rate and energy of formation of chemisorbed species can now be applied to the prediction and explanation of catalytic activity in reactions controlled by the rate of formation of ions or radicals or covalently bonded complexes, or wherein the rate-controlling step depends on the concentration of such species on the surface. By this means catalytic activity can be directly related to the energy and density of levels at the Fermi surface. The correlation explains the activity trends in binary and multicomponent alloys, where the rate of fall in activity with added *s*-, *p*-metals increases with the valency of the latter; it provides an interpretation of the changes in activity at the phase boundaries in Hume-Rothery alloys; and it goes a long way to explain the much-disputed magneto-catalytic effects of Hedvall and the observed effects of order–disorder transformation in alloys. Catalyst poisoning is also elucidated; it is now clear that the poison may be effective not only by obscuring the surface, but also through its effect on the electron work function of the solid and on the unfilled electron levels and orbitals within it.

Extension of the same principles to catalysts which are semi-conductors or insulators is more difficult, but considerable progress has been made. The same considerations show that positive ions are most easily formed on defect conductors or on insulators with easily reducible cations, particularly when the substance contains a stable component with cation defects. Conversely, negative ions are most easily formed on excess semi-conductors or on insulators with easily oxidized cations or where stable anion defects are present. (It is possible that excess semi-conductors under high hydrogen pressures function as metal catalysts.) Insulators—which neither accept nor donate electrons easily—function by chemisorbing reactants as positive and negative ions; proton exchange mechanisms are prominent, and these proceed most readily at cation defects.

In discussion, Dr. D. D. Eley (Bristol) presented experimental data on the ortho-para hydrogen conversion at the surface of palladium–gold alloys, which clearly indicated a rapid drop in activity at about 50 atomic per cent of added gold, that is, at the composition corresponding to the complete filling of the *d*-band in palladium. The drop in activity is accompanied by a large rise in activation energy and a decrease in the frequency factor, to be contrasted with the more common parallel changes in these variables. The fact that hydrogen poisons the reaction on pure palladium would appear to indicate that hydrogen itself can provide electrons to fill up the *d*-orbital of the palladium.

Dr. E. B. Maxted (Bristol) discussed evidence which showed that poisoning of platinum catalysts by transitional metal ions occurs only when the added ion has all five orbitals of a *d*-shell immediately preceding *s*- or *p*-valency shells electronically occupied. Regularities also exist in the correlation between the catalytic activities and magnetic susceptibilities of the platinum metals.

Dr. J. S. Anderson (Harwell) presented some data on the electrical properties of semi-conducting zinc oxide which suggested that at very low partial pressures of oxygen the excess zinc atoms may aggregate into small regions of two-dimensional metal.

[1] Dowden, *Research*, **1**, 239 (1948).
[2] Beeck, Smith and Wheeler, *Proc. Roy. Soc.*, A, **177**, 62 (1940).
[3] Beeck, *Rev. Mod. Phys.*, **17**, 61 (1945).
[4] Lennard-Jones, *Trans. Farad. Soc.*, **28**, 333 (1932).
[5] Pauling, "The Nature of the Chemical Bond" (1942).
[6] Pauling, *Rev. Mod. Phys.*, **20**, 112 (1948).

COLONIAL GEOLOGICAL SURVEY WORK

A SPECIAL display illustrating the work of Colonial Geological Surveys is at present being held in the Exhibition Pavilion of the Imperial Institute, South Kensington, London, and forms an integral part of the series of exhibitions being devoted to "Colonial Month". The exhibition has been arranged by the Mineral Resources Division in conjunction with the directorate of the Surveys, and is open until July 20 on Mondays to Fridays from 10 a.m. to 4.30 p.m., and on Saturdays from 10 a.m. to 1 p.m.

Since January 1, 1947, all official matters relating to the development of Colonial geological survey work have been the responsibility of Dr. F. Dixey, director of Colonial Geological Surveys and geological adviser to the Secretary of State for the

Colonies. Apart from the directorate in London, the Colonial Geological Surveys comprise twelve departments or divisions in active operation in Colonies of East, Central and West Africa, in the High Commissioner Territories of Southern Africa, in the Colonies of the Caribbean Region, and in the Far East. As soon as personnel can be found for them, additional geological surveys will commence in the West Indies, the Middle East and the Western Pacific; arrangements are in view also for the limited examination of five other Colonies. The existing surveys vary considerably in strength and in age: some of them were established early in this century, and these have already played a very important part in developing the mineral wealth of the Colonies; whereas one new survey, in the British territories in Borneo, has been established during the current year. At present there are about seventy-five geologists in the Colonial Service; but this number will be increased considerably in the near future, as provision has been made for a total strength of nearly two hundred within the next few years.

The exhibition illustrates the basic work of Colonial geological mapping, the geologist's contribution to the development of mineral deposits and water supplies, and the work in London of the Mineral Resources Division. For each Colonial geological survey department, the most recent geological map of the whole territory is displayed, together with examples of large-scale maps, and, in some cases, photographs depicting the geologist's life in the field. The wide scope of Colonial geology is emphasized by an extensive selection of maps and publications, which range from economic memoirs dealing with specific mining fields to scientific studies, such as those of the lacustrine sediments of the Nyasan Rift Valley, the palæontology of British Somaliland and Nigeria, or the petrology of volcanic rocks from Uganda, igneous intrusions and carbonatites from Southern Nyasaland, and pegmatites in central Nigeria.

Under the heading "The Mineral Wealth of the Colonies", a series of maps and photographs illustrates the important service of the geological surveys to the mining industries. The significance of this work for Colonial progress is apparent from the fact that the value of Colonial mineral production is now nearly £100 million per annum, the leading items being tin (Malaya, Nigeria, etc.), copper (Northern Rhodesia), petroleum (Brunei, Trinidad), and gold (Gold Coast, etc.). Here we find a selection of geological maps of well-known mining areas where bauxite, coal, copper, diamonds, gold, manganese, tin, etc., are produced, accompanied by photographs of some of the mines. The large geological map of Northern Rhodesia forms an interesting item in this section, as it was prepared privately by mineral concession companies and represents the work of no less than 167 geologists drawn from many parts of the world. The search for oil is illustrated by views of the producing oilfields of Trinidad, Brunei and Sarawak, and of an exploratory well being drilled by the Geological Survey of Uganda.

The vital importance of the development and maintenance of adequate water supplies in many Colonies, and the wide range of geological and engineering problems this involves, is brought out by a display of publications on water supplies together with photographs and maps.

A general exhibit shows examples from Tanganyika of different types of geological map: namely, a detailed map of a mineral area, a large-scale degree sheet designed ultimately to cover the territory on a systematic grid, and a small-scale provisional geological map of the country as a whole. The fundamental task of deciphering the stratigraphic history of little-known countries is illustrated, in the case of British Guiana, by a series of rock specimens accompanying the provisional geological map and a boldly speculative vertical section across the country. Photogeology is represented by a series of aerial photographs selected from several Colonies to illustrate the value of this technique in elucidating geological structures, this being one of the specialist services already provided by the Directorate.

On April 1 this year, the Mineral Resources Department of the Imperial Institute became the Mineral Resources Division of Colonial Geological Surveys. A consequence of this change is that the long experience acquired by this Department in the evaluation of economic minerals from all parts of the Commonwealth is now focused more sharply on the mineral development of the Colonies. Photographs of the chemical, mineralogical, spectrographic and ceramic laboratories give an indication of the facilities afforded by the Division, and exhibits of typical work carried out are presented. These include the results of technical trials on Sierra Leone lignite and clays; examples of bricks and pottery made from the latter; analyses and washing tests on Tanganyika coals; trials of pozzolanic building materials from St. Vincent; and analyses of Nyasaland bauxites. Examples of special publications are also displayed, including the well-known "Statistical Summary of the Mineral Industry", of which a new volume is to appear shortly. Other publications shown include the series of articles on the geology and mineral resources of the Colonies, with their specially prepared geological and mineral maps, which have recently appeared in the *Bulletin of the Imperial Institute*.

Small special exhibits deal with rare minerals, and with the early history of geological work in the Colonies. The selection of rare minerals includes six of the score of minerals which were first discovered and described from Colonial territories, and comprise nigerite (the new tin mineral from Nigeria), lusakite and tarbuttite from Northern Rhodesia, bismutotantalite from Uganda, and potarite (palladium amalgam) and merumite (hydrated chromic oxide) from British Guiana. Above this exhibit are photographs of large alluvial diamonds, including the largest existing diamond in the world, found a few years ago in Sierra Leone, where diamonds were first discovered by the Geological Survey Department.

The historical section shows a few examples of early geological maps by pioneer explorers, and includes J. R. Logan's map of Singapore published in 1851; Dr. Livingstone's crude geological section across Africa on the route by which he crossed the continent during 1853–56; and the first geological map of East Africa from Joseph Thomson's expedition of 1878–80. Maps of Trinidad (1860) and Jamaica (1865), published in memoirs of the Geological Survey of Great Britain, mark the first official geological work in the Colonies. Finally, two maps of Nigeria illustrate the results of the Imperial Institute Mineral Surveys of the period 1903–14, which were the forerunners of the present geological surveys in both Nigeria and Nyasaland.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

NEWCASTLE UPON TYNE MEETING

THE meeting this year of the British Association at Newcastle upon Tyne is the fifth of a series commencing in 1838—the first occasion on which ladies were admitted as members. The meeting will be held during August 31–September 7, and will commence with a special congregation of the University of Durham at which the president of the Association, Sir John Russell, will receive the honorary degree of D.Sc.

There is no official overriding topic for the meeting; but the particular interests of the president have already lent colour to the programme. At the Newcastle meeting in 1916, he was already a brilliant agricultural scientist and presided over Section M. This year his presidential address will be on "World Population and World Food", and there will be a symposium on the same subject later in the week under the auspices of the Division for the Social and International Relations of Science. At this public meeting Dr. Jaime Torres Bodet (Director-General of Unesco), Lord Horder and others will join the president in discussion. Single aspects of this general problem will be considered in eight of the thirteen Sections.

Most of the sectional meetings will take place in King's College (University of Durham), the buildings of which all lie within a short distance of each other. The new Science Block, two of the wings of which are now reaching completion, will be used for the first time to house Sections A and B. The only outlying section is L (Education), which will meet in the Royal Grammar School, a few minutes walk from King's College. Members will find movement from one Section to another easy, and the provision of six hundred lunches a day for the Association in the Civic Restaurant adjoining the reception room goes far towards making the meeting self-contained.

Hotel accommodation in Newcastle itself is restricted, and most spare places have already been taken for the week of the meeting. Members will find it easier to obtain accommodation in the coastal districts (easily reached by electric train) or in the residential colleges of the University of Durham (special bus service). The Hospitality Sub-committee is anxious that all applications for accommodation should be made as soon as possible.

This year, members will be given more varied and complete local information than has been possible since the War. The Lord Mayor and Corporation will present to each member a copy of their new publication, describing in text and photographs the outstanding features of the city. An editorial team is at present working on the production of a "Scientific Survey of North-Eastern England", which is printed and bound by Newcastle firms, and on the style, typography and lay-out of which the guidance and advice of Sir Francis Meynell has been much appreciated by the Publications Sub-committee. The subject-matter of the Survey falls naturally into five sections: natural history, regional settlement, industries, agriculture and fisheries, and Newcastle upon Tyne. The region has characteristics which are distinct from those of the rest of England, and from Scotland. Its importance is, of course, mainly due to its coal-mining and heavy industry, and for this reason the geology of the area is of great importance, and is very carefully described. The section on industries opens with articles on the extractive industries, which include not only coal and iron, but also lead, fluorspar and silver. Shipbuilding suffered a slump during the early thirties, but took on a heavy programme of building and repairing during the War. The names of Sir Charles Parsons, the Stephensons, and Sir Joseph Wilson Swan are kept before the reader, who will obtain a clear picture of the historical and modern aspects of the applications of science to industry. The group of contributions dealing with the flora and fauna of the area will be of considerable value to members who take part in excursions to the Farne Islands, Glanton and Gosforth Park bird sanctuaries or to the interesting botanical moors and mosses which form part of the programme of Section K.

In all, 117 excursions have been arranged, 70 being of sectional interest, and 47 illustrating broadly the region of which Newcastle forms the centre. These visits range in distance from Middlesbrough to the Lake District, and include such items of interest as visits to coal-mines and attendance at a ship launch if one takes place during the week. One of the most popular of the general excursions will be a trip down the River Tyne, by kind invitation of the Tyne Improvement Commission. Inland, Sir Charles and Lady Trevelyan have extended hospitality to several parties, the members of which will have the opportunity of visiting Wallington Hall, with its magnificent collection of oriental porcelain.

Other treasures of the district are not forgotten. A party will visit High Force and Swaledale and enjoy an eight-mile walk on the moors. Others will see the Roman settlements of The Wall, and several groups will visit Durham with the particular object of seeing the Castle and Cathedral. Some of those accommodated in the Durham Colleges will have the privilege of living in the Castle during the week.

Prominent among the excursions are visits to the industrial works for which the North-East is famous. Everywhere, the local officers have found enthusiasm and co-operation, and members will be welcomed by firms and by civic heads of the neighbouring authorities on the banks of the Tyne, Tees and Wear.

Turning to the topics of discussion which form the main business of the meeting, we find that the subject of education runs through the programme of several sections. Section C discusses "Education of the Professional Geologist", and Section J "Psychology and the Teacher". Four Sections consider "Field Study Centres", which do much to assist biological and geological education. Sir Fred Clarke's presidential address to Section L on "The Widening Scope of the Study of Education" is followed by the controversial theme of "Technology and the Humanities in Further Education". The section of most interest to the president will hear a presidential address by Prof. N. M. Comber on "Farming Science and Education" and will go on to discuss "Hill Farming and Forestry", "Agricultural Ecology" and other topics.

Ecology also forms the theme of one meeting of Section D, when "Marine Ecology" will afford opportunity for discussion on a topic linked to the work of the Dove Marine Laboratory at Cullercoats on the coast. This Laboratory is maintained by King's College, and the visit which Section D will pay to it will be of particular interest, for the area contains both northern and southern species more or less at

the limits of their territory. "Marine Propulsion" and "River Pollution" are certain to attract members from outside the specialized field of zoology.

Of considerable interest in a major coalfield will be Section G's discussion on "Ground Subsidence Caused by Mining and its Effect on Town Planning", particularly in view of the plans for the new town of Peterlee, which are vitally influenced by the possibility of mining subsidence. Other topics suggested by the presence of the surrounding coalfield are "The Present Position of the Coal Industry in Great Britain" (Section F), and "Heating Research for Houses" (Section G).

In the evenings, members will find a variety of attractive gatherings. Three evening discourses, by Dr. Hans Pettersson, leader of the Swedish Deep-Sea Expedition, by Dr. Julian Huxley and by Prof. A. D. Ritchie, will be held in the lecture hall of the Literary and Philosophical Society. Most sections are holding dinners, and various local societies have extended invitations to conversaziones and discussions. The Natural History Society will entertain members of several sections, and the delegates of Corresponding Societies. The Northern Industrial Group will invite certain sectional officers to tea and discussion, and the North-East Coast Institution of Engineers and Shipbuilders will bring together those members interested in Section G at a conversazione in the Old Assembly Rooms. Section G will also be entertained at King's College.

Hospitality will be extended by the Lord Mayor and Corporation in the form of a dance and a concert. The dance will be held in the eighteenth-century Old Assembly Rooms, and the concert in the City Hall. At the latter event members will hear choirs and solo performers from the North-East, and the programme will contain a proportion of the traditional music for which Northumberland is well known.

Throughout the week exhibitions of many kinds will be open to members in the sectional rooms, and in the King's Hall lounge which forms the social centre of the meeting.

W. Fisher Cassie
(Hon. Joint Local Secretary)

NEWS and VIEWS

Royal Society of Edinburgh : Honorary Fellows

At a meeting of the Royal Society of Edinburgh held on July 4, the following were elected foreign and British honorary fellows of the Society : *Foreign :* Prof. L. W. Collet, professor of geology, University of Geneva ; Dr. J. G. Davidson, president, Carbide and Carbon Chemicals Corporation, New York ; Prof. E. Fermi, professor of nuclear physics, University of Chicago ; Dr. Irving Langmuir, associate director of the Research Laboratory, General Electric Company, New York ; Dr. J. H. Oort, director of the Leyden Observatory ; Prof. C. J. F. Skottsberg, professor of botany, University of Göteborg, and director of the Botanical Gardens, Göteborg. *British :* Prof. D. M. S. Watson, Jodrell professor of zoology and comparative anatomy, University College, London ; Prof. G. N. Watson, professor of pure mathematics, University of Birmingham.

Engineering at Nottingham : Prof. C. H. Bulleid, O.B.E.

Prof. C. H. Bulleid, who is retiring from the chair of civil and mechanical engineering in the University of Nottingham, obtained a scholarship to Exeter School in 1889 and was awarded an open scholarship to Trinity College, Cambridge, in December 1900, whence he graduated first class (14th Wrangler) in the Mathematics Tripos (1904) and first class in the Mechanical Sciences Tripos of 1905. He then spent two years in demonstrating and lecturing in the Engineering Laboratories and Trinity College, before going to the Midland Railway, Derby, as a pupil of R. M. Deeley, who was then the locomotive superintendent. Here he obtained wide experience in the workshops and drawing office, and on the footplate. It is interesting to note that he took part in the tests of the first superheater engine built by the Midland Railway. From March 1911 until September 1912 he acted as assistant to the technical manager of the Parsons Marine Steam Turbine Co., Wallsend-on-Tyne. All this experience was a fitting prelude to his appointment as professor at the University College, Nottingham, where he was responsible for the day and evening engineering classes for all evening technological courses. During the First World War, Prof. Bulleid was a member of the Nottingham Munitions Committee and general manager of the Nottingham Shell Factory ; for this work he was awarded the O.B.E. His further war service was as chief engineer in the Admiralty School of Mines, Portsmouth. At the close of hostilities he returned to University College, Nottingham, where he has carried out researches on the fatigue of cast iron and on the vibration of shafts. He has always been closely in touch with local industries and has frequently acted as consultant and expert witness. He has achieved considerable eminence as a teacher of engineering subjects, and has seen his Department grow from very small beginnings to that of a flourishing university.

Prof. J. A. Pope

Dr. J. A. Pope, who has been appointed to the chair of engineering in the University of Nottingham in succession to Prof. C. H. Bulleid, served a five-year apprenticeship in mechanical engineering at Messrs. Boulton and Paul, Ltd. Awarded a Whitworth Scholarship in 1935, he commenced his scholastic training and research career at King's College, London. In 1938 he was appointed lecturer in mechanical engineering in the Queen's University, Belfast, where his teaching was mainly concerned with the strength of materials and engineering metallurgy. Here his researches on the deformation of metals during impact were recognized by the award of a Ph.D., and of the George Stephenson Prize by the Institution of Mechanical Engineers. Leaving Belfast, Prof. Pope spent a year at Manchester before joining the staff of the University of Sheffield in 1945 as lecturer in mechanical engineering. While concerned with the theory of machines and thermodynamics in his normal teaching at Sheffield, Prof. Pope extended his researches into the properties of materials to include the effects of torsional overstrain on spring wire, of compound-fatigue stresses,

and on the failure of cast iron due to thermal shock. His work has brought him into close contact with wide industrial interests, and he was responsible for research programmes carried out at the University of Sheffield for the Coil Spring Federation and for the British Shipbuilders Research Association. The value of his many published papers was recognized by the award of the D.Sc. (Belfast) in 1949 and by his appointment as a senior lecturer in mechanical engineering at Sheffield. Prof. Pope takes up his new duties at Nottingham in October.

American Geological Institute

Dr. David M. Delo has been recently appointed as the first executive director of the American Geological Institute. Dr. Delo, who is a graduate of Miami and Harvard Universities, has served for the past three years as chief of scientific man-power for the Research and Development Group, Logistics Division, General Staff, U.S. Army. During the Second World War he was a technical aide in the Office of Scientific Research and Development, and prior to that time was chairman of the Department of Geology and Geography, Knox College.

The American Geological Institute is a new organisation, established in November 1948, which will represent the profession of geology. It is composed of a union of eleven geological societies, the members of which total more than ten thousand professional geologists. Headquarters will be at the National Research Council, 2101 Constitution Avenue, Washington 25, D.C., and the activities of the Institute will be carried on in conjunction with those of the Division of Geology and Geography of the Council. The primary objectives of the new Institute are the advancement of geology and its application to human welfare by providing a means for the co-operation of organisations active in the fields of pure and applied geology. Membership is open to all non-profit organisations concerned with the earth sciences—geology, geophysics, geochemistry, mineralogy, etc. The initial member organisations are: American Association of Petroleum Geologists, American Geophysical Union, American Institute of Mining and Metallurgical Engineers, Geological Society of America, Mineralogical Society of America, Paleontological Society, Seismological Society of America, Society of Economic Geologists, Society of Economic Paleontologists and Mineralogists, Society of Exploration Geophysicists, and Society of Vertebrate Paleontology. Officers of the Institute are: *President:* A. I. Levorsen, dean of mineral sciences, Stanford University; *Vice-President:* W. B. Heroy, of Beers and Heroy, Dallas, Texas; *Secretary-Treasurer:* Earl Ingerson, U.S. Geological Survey, Washington, D.C.

Sir William Osler (1849–1919)

Clinician, epidemiologist, pathologist, teacher, historian, classical scholar, bibliographer and bibliophile, Sir William Osler, who was born a century ago, on July 12, 1849, has left a legacy of more than fifteen hundred publications and has inspired an even vaster legacy of writings about himself. His biography by Harvey Cushing (1925) is in two large volumes, and his "Memorial Volume" (1926) fills more than six hundred pages. Osler studied medicine at Toronto, Montreal and in Europe, his subsequent teaching as professor of medicine at McGill, Philadelphia and Oxford embodying the best features in English and European—especially German—methods, but always characterized by the ideal expressed in his self-selected epitaph, "He taught medicine in the wards". Sir Arthur MacNalty, in his article "Osler as a Scientist" (*Nature*, **162**, 346; 1948), dealt fully with Osler's original contributions to scientific medicine, particularly his investigations of the blood-platelets and the malarial parasite, and his studies on malignant endocarditis. While Osler's signature is written on nearly every page of medicine, his name has been specifically attached to two diseases: hereditary epistaxis with hæmorrhagic telangiectasis, and polycythemia rubra vera splenomegalica. We also speak of 'Osler nodes' in malignant endocarditis. "The Principles and Practice of Medicine" (first edition 1892) was with several generations of medical students and practitioners one of the most popular text-books in the English language. Osler lavished much of his time and energies on the task of arousing public interest in tuberculosis and the venereal diseases. He was a convincing speaker with a gift for the telling phrase. More than a great man of science and a great physician, he was a radiant personality with a genius for friendship. He died at Oxford on December 29, 1919, of pneumonia—a disease which had held a peculiar fascination for him all his life.

Committee on Industrial Productivity

In *Nature* of May 21, p. 781, comment was made on the first annual report of the Committee on Industrial Productivity. This Committee is one of a series of Government committees studying problems of productivity, and it is claimed that it is the only committee deliberately set up to study the matter from the scientific point of view. It is, therefore, supplementary to the main work of economists, and there is no suggestion in the minds of its members or of anyone in Government circles that it has prime responsibility. The Committee works through a number of more specialized panels, among which is the Import Substitution Panel, and it was suggested in *Nature* that this Panel might have been headed by an economist. The Panel consists of representatives of the Economic Section of the Cabinet Office, the Ministry of Food, the Colonial Office and representatives of industry. We are informed that its recommendations are discussed by the main Committee, upon which sit other economists. When endorsed by this Committee, they are referred to appropriate departments and finally considered again by the Central Planning Board under Sir Edwin Plowden, before being submitted to Ministers. Furthermore, the preliminary discussions of the Panel have in all cases been aided by specialist advice from interested bodies, whether from Government departments or from private industry or agriculture. The purpose of setting up a partly scientific committee to deal with economic matters was to bring to bear on them the same kind of scientific thought as proved so useful in what was called 'operational research' during the War, with the view of making the best and most economic use of the resources available and deciding in what direction scientific and technical improvements are likely to give the greatest dividends.

Technical Education

In his presidential address to the annual conference of the Association of Teachers in Technical Institutions, Mr. H. W. Wadge, of Sheffield, declared that the expansion of technical education must be given top priority by the Minister of Education if Britain is to maintain its economic position during

the coming years. The recent statement by the Minister that, by 1952, a building programme is to be carried out which should meet all existing needs for technical education offers much encouragement and should be accompanied by the recruitment of staff possessing not only high academic or technological qualifications but also appropriate industrial experience. Men and women of suitable standard would only be obtained if the financial rewards were commensurate with those in other fields, and in every college the full permissible quota of special posts and senior assistantships should be adopted. The wide variation in the rates of payment to part-time teachers in different localities should be discontinued and superseded by a national scheme bearing a satisfactory relationship to full-time Burnham scales. Mr. Wadge also pleaded that no student who obtains a technical State scholarship should find himself precluded from taking an appropriate university course merely because he does not satisfy university entrance requirements primarily designed to assess the capacity of candidates entering directly from secondary school courses.

"Colonial Month" Exhibition at the Horniman Museum

In connexion with the "Colonial Month" being held in London, the Horniman Museum, Forest Hill, London, S.E.23, has arranged an exhibition of ethnographical and entomological specimens from British Colonies, representative of the four continents. For America, British Guiana was chosen, and implements from the Waiwai and Wapishana tribes are shown; their personal ornaments are most colourful and usually consist of eagle and macaw feathers. From the African Continent, Nigeria and Sierra Leone are most representative from the point of view of craftsmanship; wooden figures and masks from the Ekoi, Ibibio, Munshi and Yoruba tribes, and good examples of Benin bronzes are displayed. Oceania is represented by specimens from three different island groups, comprising the New Hebrides, Solomon Islands and Fiji. Among other exhibits, perhaps the most interesting are examples of Fijian bark-cloth, and implements used in its manufacture. In Asia, examples of the Dyak culture of Borneo complete the picture from the four continents. An exhibition of butterflies and other insects, including *Papilio Hornimani*, is also on view.

Marine Radar Research in Canada

Radar investigations form an important part of the programme of the recently formed Radio and Electrical Division of the National Research Council of Canada (see *Nature*, **161**, 513; 1948). The Council has equipped the motor vessel *Radel* as a floating laboratory to assist in the investigation of the special problems associated with the application of radar to mercantile marine navigation. With the opening of navigation on the Great Lakes and other Canadian inland waterways during May, the *Radel*, under the command of Mr. H. Ross Smyth, began her 1949 programme. The prototype model of a merchant marine radar developed in the laboratories of the Council is noteworthy for its short minimum detection-range of twenty-five yards. Some of the experiments for this year are designed to reduce this range to enable a vessel to enter narrow harbour gaps and to dock at crowded piers without needing visual aid. Another project for the work of this season is the development of coded reflector buoys, which are made non-reflecting in a periodic code sequence so as to facilitate the positive identification of the buoys used for channel and shore-line markers. Initial experiments will also be conducted on a 'microwave lighthouse', which will make it possible for ships to take accurate bearings on a shore beacon regardless of weather conditions.

Hydro-Electric Potentialities of the Gold Coast

Sir William Halcrow and Partners have agreed to undertake, on behalf of the Gold Coast Government, a survey of the hydro-electric potentialities of that territory. The survey will have particular reference to: hydro-electric power at Ajena and/or Bui; irrigation and drainage of lands in or near the Volta catchment; and the provision of port facilities at either Ada or Accra. The terms of reference of the survey also relate to the possibility of improving transport by developing a system of navigation on the lake which would be formed by the proposed dam near Ajena and by any other means. Transport requirements which would result from the establishment of an aluminium factory will be considered. Recommendations will be made as to what proportion of the power generated by any hydro-electric schemes should be devoted to aluminium production and what proportion to other industries and towns. The effect of development on native systems of land tenure and water rights will receive special examination. The survey panel will be composed primarily of engineers provided by the firm of consultants and of Government geological, soil and land experts.

Atomic Physics in the United States

Among the important articles in the current issue of *American Scientist* (**37**, No. 2; April 1949) is one by J. Tiomno and John A. Wheeler of Princeton University which gives a valuable list of original papers dealing with researches in atomic physics. Recent advances in this field have been so rapid that the production of general treatises and monographs has lagged behind the output of original papers. Tiomno and Wheeler's list, which includes references to papers announced up to December 1948, is divided into two parts, the first enumerating the major topics in atomic physics and the second the list of references themselves. The article is preceded by one by Carl D. Anderson of the California Institute of Technology reviewing the historical development of the physics of elementary particles.

Merger of Management Institutes

An agreement designed to bring about a merger between the British Institute of Management and the Institute of Industrial Administration by two stages has recently been signed. During the first stage, which comes into effect immediately, the Institute of Industrial Administration, which has been in existence for thirty years and has a membership of six thousand, will retain its separate identity, and its professional activities will continue unchanged; but its executive management, subject to the policy control of its own Council, will be undertaken by the staff of the British Institute of Management. The merger will be completed in the second stage, which is expected to come into effect in two or three years time. Meanwhile, the British Institute of Management will encourage managers desiring professional qualifications in general management to join the Institute of Industrial Administration.

National Institute of Sciences of India: Research Fellowships

At the meeting of the Council of the National Institute of Sciences of India held at Bangalore on May 6, research fellowships were awarded to the following for work in particular fields at the places shown. *National Institute of Sciences Senior Research Fellowships:* U. R. Burman (internal constitution of the stars), University of Calcutta; Dr. A. B. Kar (endocrinology with special reference to birds), Central Drugs Laboratory, Calcutta; Dr. S. M. Mukherji (use of metal–ammonia reduction method in the syntheses of naturally occurring substances and valuable intermediates), University of Calcutta; Dr. K. V. Srinath (cytology), Central College, Bangalore. *National Institute of Sciences Junior Research Fellowships:* Miss Ira Bose (effect of ionizing radiations on chromosomes of the grasshopper), University of Calcutta; S. Datta Majumdar (relativity and quantum mechanics), University of Calcutta; Dr. S. G. Joshi (mineral nutrition of plants and microbial and biochemical activities in the soil), Fergusson College, Poona; T. M. Mahadevan (study of rare minerals of Madras Presidency), Presidency College, Madras; D. K. Mukherji (plant physiology (embryo culture) applied to plant breeding), Indian Agricultural Research Institute, New Delhi; K. Subramanyam (embryology and floral anatomy in some members of the Melastomaceæ and the embryology of the Lobeliaceæ, Campanulaceæ and Stylidiaceæ, and their interrelationships), Central College, Bangalore; B. V. Sukhatme (theory of certain distributions in non-parametric tests and their applications), Indian Council of Agricultural Research, New Delhi. *Imperial Chemical Industries (India) Research Fellowships:* A. K. Chakravarti (cytogenetics of some common fruit trees of India and the application of colchicine to raise improved types), University of Calcutta; Dr. A. P. Mahadevan (studies in the pterin field), University of Madras; C. Ramasastry (spectroscopy), Andhra University; Dr. K. K. Reddi (role of anti-thiamine factor in nutrition), Indian Institute of Science, Bangalore.

Commonwealth Fund Fellowships

The committee of award of the Commonwealth Fund Fellowships has made the following appointments, among others, to fellowships tenable in American universities for one year, beginning September 1949, by British graduates: R. E. D. Bishop, University College, London, to Stanford University (engineering); Dr. J. Glover, Belfast and Liverpool, to Washington University (chemistry); A. M. Michelson, King's College, Durham, and Pembroke College, Cambridge, to the California Institute of Technology (chemistry); J. C. S. Paterson, St. Andrews, and the Post-Graduate Medical School, London, to the University of Rochester (medicine); Miss A. J. Pinsent, Newnham College, Cambridge, and Lister Institute, London, to the Hopkins Marine Station, Stanford (chemistry); Dr. W. I. Pumphrey, Birmingham (engineering); Dr. C. A. Rogers, University College, London, to the Institute for Advanced Study, Princeton (mathematics); Dr. G. J. Romanes, Christ's College, Cambridge, and Edinburgh, to Columbia University (medicine); G. Smith, St. Andrews and Glasgow, to Johns Hopkins University (medicine); L. C. Taylor, New College, Oxford (psychology); D. Walker, Auckland and Birmingham, to Cornell University (physics); P. J. Wheatley, Queen's College and Merton College, Oxford, to the University of Minnesota (chemistry).

Three appointments have been made to fellowships tenable by candidates from the Home Civil Service: Miss D. E. Ackroyd (Oxford), of the Ministry of Supply; H. J. Gray (London), of the Board of Trade; J. A. C. Robertson (Cambridge), of the Treasury.

National Research Development Corporation

Replying to a question in the House of Commons on June 30, the president of the Board of Trade said that Sir Percy Mills has accepted his invitation to become chairman of the National Research Development Corporation. Five other directors have also been appointed: Prof. P. M. S. Blackett, Sir John Duncanson, Sir Edward Hodgson, Mr. W. E. P. Johnson and Sir Edward de Stein. The managing director of the Corporation, which came into formal existence on June 28, is Lord Halsbury.

Recent Advances in the Fermentation Industries

A symposium on "Recent Advances in the Fermentation Industries" has been arranged by the Scottish Sections of the Royal Institute of Chemistry and will be held at the University of St. Andrews during July 23–30. July 25, 26 and 27 will be devoted to the respective topics of edible and potable fermentation products, industrial fermentations, and microbiological advances; and on July 29 and 30 members may attend the meetings of the Biochemical Society at University College, Dundee, and of the Physiological Society at United College Hall, St. Andrews, respectively. Further information may be obtained from the Principal Assistant Secretary, Royal Institute of Chemistry, 30 Russell Square, London, W.C.1.

Announcements

Mr. O. V. S. Bulleid has been elected president of the Institute of Welding for the year 1949–50. Mr. Bulleid, who is about to retire from his present post as chief mechanical engineer, British Railways, Southern Region, has been appointed consulting mechanical engineer to Coras Iompair Eireann (Irish Transport Company).

Mr. W. K. Wallace, chief civil engineer to British Railways (London Midland Region), has been appointed chairman of the Building Research Board in succession to Sir George Burt.

The 1949 annual meeting of the Electron Microscope Society of America will be held in Washington, D.C., during October 6–8, with the National Bureau of Standards as host. A programme of contributed and invited papers will be presented. All those interested in electron microscopy are invited to attend the meeting. Further information may be obtained from the chairman of the programme committee, R. G. Picard, Radio Corporation of America, R.C.A. Victor Division, Camden, N.J.

On p. 982 of his article "Soviet Genetics: the Real Issue" (*Nature*, June 25, p. 974) Dr. Julian Huxley suggests that an affirmation of the rights and duties of men of science should be prepared. Such an affirmation has already been drafted by the executive council of the World Federation of Scientific Workers and has been published under the title "Charter for Scientific Workers" in the journal of the Federation, *Science and Mankind* (Vol. 1, p. 78; January 1949).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Hæmoglobin in Crustacea

HÆMOGLOBIN is found in the Crustacea. It occurs dissolved in the blood plasma of the Notostraca[1,2], Anostraca[3], Cladocera[3,4], and parasitic Copepoda[5,6] although it is absent in free-living ones[2]. I have not been able to find hæmoglobin in the Branchiura (*Argulus*). It is found, however, in Ostracoda[7] and in a parasitic member of the Cirripedia[8]. All these groups are Entomostraca; hæmoglobin is unknown in the Malacostraca. Among the latter, the Decapoda have hæmocyanin as a respiratory blood pigment. I have now found hæmoglobin in the one remaining group of the Entomostraca, namely, the Conchostraca, in which, to my knowledge, it has not yet been sought.

There is hæmoglobin in the blood of the conchostracans *Lynceus simiæfacies* Harding and *Leptestheria mayeti* (Simon). The former was hatched in London by Dr. J. P. Harding from dried mud brought from Arabia[9]. The latter I found abundantly in April of this year in shallow temporary pools of the Oued Melias at Béni-Ounif on the border of the Algerian Sahara. The animals were pinkish-brown and the oxyhæmoglobin spectrum was strong. This conchostran had much more hæmoglobin in its blood than the anostracans *Branchipus stagnalis* (L.) and *Tanymastix perrieri* Daday of similar dimensions, crowded together with it in the same pools.

In subsequent laboratory experiments I have found that *Leptestheria*, just like *Daphnia*[7,10] and *Triops*[3], synthesizes much more hæmoglobin in oxygen-deficient water than in well-aerated water. *Leptestheria*, raised from the egg at 19° C., attained sexual maturity in a fortnight. Reared in aerated water these animals were brown. Some were then put into water only 17 per cent saturated with air, others into water 75 per cent air-saturated. After a week the latter were still brown but the former were bright pink. The spectroscope showed that the pink colour was due to a higher hæmoglobin content of the blood in these than in the brown animals. As suggested by my colleague Mr. D. S. Johnson, the habit of *Leptestheria* of grubbing and sometimes burrowing in the sandy mud may partly account for its high hæmoglobin content compared with that of the free-swimming fairy shrimps, its companions in the pools, for oxygen would be more deficient in the mud than in the water above it.

Not only Notostraca, Conchostraca and Cladocera increase their hæmoglobin in conditions of oxygen deficiency, but also Anostraca. Miss Barbara Gilchrist in this laboratory has lately found that *Artemia salina* (L.), cultured for 2–3 weeks at 18–20° C. in water only 10–20 per cent saturated with air, develops pink blood which shows strong oxyhæmoglobin absorption bands, while the controls in aerated water have colourless blood without a trace of the oxyhæmoglobin spectrum. Since members of four groups of Crustacea react to oxygen lack by hæmoglobin synthesis, this property seems to be general in hæmoglobin-bearing crustaceans, just as it is in vertebrate animals, among which it is manifested by human mountaineers, by rabbits and by fish[11,12].

I was able to observe and collect phyllopods in desert pools, thanks to the hospitality of the Laboratoire de Biologie Saharienne of the University of Algiers and to generous financial aid by the Muséum National d'Histoire Naturelle of Paris, by the French Centre National de la Recherche Scientifique, and by the Centre de Recherches Sahariennes. I wish to thank these bodies most sincerely for their international scientific gesture.

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Auditory Adaptation in the Human Subject

As is well known, raising of the threshold of hearing is caused by exposure to a continuous tone. The magnitude of this effect is a function of the frequency, duration and intensity of the tone. In general it is small, with intensities which do not exceed 90–100 db. above normal threshold in the middle frequency range.

The threshold measurements required for the demonstration of this type of fatigue are carried out *following* the application of the stimulus. We have, therefore, found it convenient to term it *post*-stimulatory fatigue.

By means of a binaural loudness balance technique, it has been possible to demonstrate and investigate a form of fatigue which appears *during* the application of a fatiguing tone, and may be termed *per*-stimulatory fatigue. Two audiometers supply separate ear-pieces, and it is possible by means of an appropriate switching arrangement to stimulate either or both ears. The audiometer on the subject's right is provided with a simple mechanical intensity-level recorder. The two audiometers are first adjusted to the same frequency, for example, 1,000 c./s. The intensity at the subject's left or test ear is kept constant at, say, 80 db. above threshold. The intensity at his right, or control, ear is then varied, in a rhythmical manner over an intensity range of some 5 db., to give

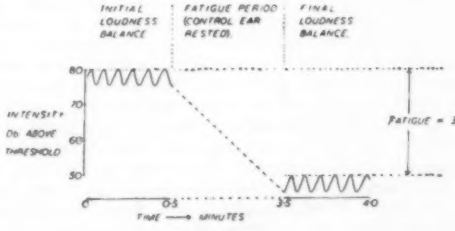

Fig. 1

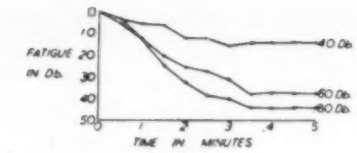

Fig. 2

equality of loudness with the constant tone in the left ear. The resulting record of the intensity level at the right ear appears on the left of Fig. 1 (initial loudness balance).

The effect of fatiguing the test ear is also shown in Fig. 1. Following the initial loudness balance which is attained with equal intensities at the two ears, the variable tone is switched off from the right ear, while the constant tone in the left ear is continued. After a period which may be determined at will, the variable tone is re-applied to the right ear and a loudness balance is then found to be attained with an intensity in the right ear which is less than 80 db. by an amount which may be considerable and depends within certain limits upon the duration of the constant tone. It will be seen, therefore, that during the period of application of this latter, a loss of sensitivity or fatigue of the left, or test, ear has occurred which is measured by the change, 30 db., in the level at the control ear required to give the final loudness balance.

Unlike *post*-stimulatory fatigue, *per*-stimulatory fatigue is present at all intensities. Moreover, it does not increase indefinitely with the duration of the fatiguing stimulus but reaches a maximum after about 3½ min. The process of recovery, too, is markedly different from that of *post*-stimulatory fatigue, being rapid in the first ten seconds and complete after about one minute.

Fig. 2 shows the development of *per*-stimulatory fatigue, in particular its attainment of a maximum in a period of approximately 3½ min. The length of this period is found to be independent of the intensity of the fatiguing tone. Fig. 3 shows the recovery process of *per*-stimulatory fatigue.

It is of interest to note that 3½ min. is approximately the period of maximal decline in the amplitude of the action potential response to a constant tone stimulus of the cochlear nerve of the cat. This slow decline has been termed 'slow equilibration' by Derbyshire and Davis[1].

The recovery curve of *per*-stimulatory fatigue bears a resemblance also to that of adaptation in a peripheral sensory muscle end-organ as described by Matthews[2].

These similarities suggest a significant relationship between these phenomena observed in the peripheral nervous system and the neural mechanism which underlies *per*-stimulatory fatigue, although it is clear that in the case of the latter its subjective character makes it necessary to take into account fatigue processes occurring within the central nervous system.

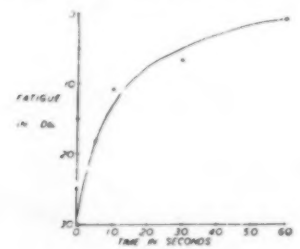

Fig. 3

It is hoped to provide further data upon the locus and neural mechanism of *per*-stimulatory fatigue by means of its study in individuals suffering from known pathological conditions of the cochlear end-organ and nervous pathways.

In addition, further studies are being undertaken of the relationship of our own findings to those of Göran de Maré obtained by a somewhat different experimental procedure, and fully described in his monograph[3].

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Transport of Insects on the Exterior of an Aircraft

All aeroplanes arriving at Piarco Airport, Trinidad, B.W.I., are sprayed with a pyrethrum aerosol immediately on landing, irrespective of whether a certificate of spraying during flight has been furnished by the pilot. After spraying, the interior is searched by staff of the Malaria Division of the Health Department, and any insects found, dead or alive, are submitted to the entomologist of the Division for examination. Any insects received which are of possible agricultural importance are sent by him to the Entomological Department, Imperial College of Tropical Agriculture.

On March 24 last, during the halt at Piarco of an Aerovias Brazil liner on passage from Rio de Janeiro to Miami, a Customs officer, leaning against the wing of the aeroplane, found his uniform soiled by having come into contact with what he recognized to be eggs of an insect. He thereupon called one of the staff of the Malaria Division, who scraped part of the egg-mass into a specimen tin.

The eggs, which were sculptured and mixed with hairs, indicating lepidopterous origin, were hatched in the insectary at the Imperial College of Tropical Agriculture and were identified as being a Noctuid near *Phytometra*, a genus that contains several important plant pests. No attempt was made to find an acceptable food-plant to complete the life-cycle.

The following details of the movements of the aeroplane have been obtained from the airline: (i) Route: Rio de Janeiro–Anapolis (State of Goias)–Belem–Piarco–Cuidad Trujillo (Dominican Republic)–Miami (U.S.A.); (ii) the aeroplane remained overnight at Belem, but did not go into hangar; (iii) maximum elevation attained en route, 10,000 ft.; (iv) this line's aeroplanes have the exteriors washed at both terminals.

Wing Comdr. Frost, R.A.F., Air Ministry meteorologist at Piarco, informs us that at the elevation stated, between Belem and Piarco, it is unlikely that temperatures lower than 10° C. would be encountered.

In any event, since the eggs hatched, no lethal temperature was attained.

The moth, probably attracted by the bright lights of the airport, presumably oviposited on the wing of the aeroplane during the overnight halt at Belem. The eggs hatched on March 27—assuming oviposition on March 23 at Belem, in about seventy-two hours. A large egg-mass frequently hatches over a considerable period of hours. If hatching had occurred during flight, at a time when the aeroplane was over land, the young larvæ, swept off by the slip-stream, might have been distributed over some hundreds of miles of country. There would, therefore, be every possibility of a few of the larvæ falling upon a suitable food-plant, and thus introducing a foreign insect.

The existing regulations deal only with insects transported within the interior of an aeroplane. While it is unlikely that insects of medical importance would be carried on the exterior, the present instance, which we believe to be the first recorded, of a possible agricultural pest being transported on the exterior of an aeroplane, suggests that this matter calls for consideration by plant quarantine authorities throughout the world.

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Serological Characters of Hog Gastric Mucin

During the course of an investigation into the nature of the 'virulence-enhancing factor' of hog gastric mucin, the mucoid materials obtained from individual pig stomachs were examined for their serological specificity in terms of certain of the human blood group characters.

Meyer, Smyth and Palmer[1] first demonstrated the human blood group A character of a purified mucoid isolated from commercial hog mucin, and more recently another mucoid component was shown to possess the so-called human group 'O' character[2]. Evidence that the 'O' substance is not a product of the *O*-gene but is most probably a basic material, heterogenetic in character, was presented[3], and this mucoid was designated 'H-substance' to avoid confusion with the true product of the *O*-gene.

The isolation of mucoid material from 120 individual pig stomach linings made possible a more extensive examination of the distribution of the A and H serological characters than had hitherto been undertaken. The fresh, minced stomach linings were allowed to autolyse at *p*H 3 and at 37° for one week in the presence of toluene. The undissolved residue was removed and the soluble mucoid material precipitated by the addition of five volumes of ethanol cooled to − 18°. The yield of crude mucoid was usually 3–4 gm. from each stomach lining.

The serological examination of the soluble mucoid materials so obtained was carried out as described earlier[4,5]. The H-activity was, however, determined by the inhibition of the agglutination of O-cells by a naturally occurring eel (*Anguilla vulgaris*) serum[6] The serum at a dilution of 1 : 100 agglutinated group O cells strongly but was without action on A_1B-cells. The agglutinating action of the eel serum was completely inhibited by human H-substance obtained from saliva or pseudomucinous ovarian cyst fluids[7].

The results of the inhibition tests revealed that seventy specimens (58 per cent) showed **A**-activity, whereas the remaining materials (42 per cent) possessed H- but not A-character. It was observed, however, that those specimens which showed A-specificity also showed H-activity, the amount of the latter serological character varying from 1 to 50 per cent of the activity of the 'standard' H-mucoid which was included in all inhibition tests. Rather more than 50 per cent of the A-active stomach preparations showed H-activity equivalent to between 6 and 12 per cent of the 'standard' H-substance, which was itself about three times less active than the purest specimens of human or hog H-substance we have obtained.

Blood-group character	Serological activity measured	Per cent of stomach preparations falling in group showing of activity of 'standard' A- or H-substances							
		1·5	3	6	12	25	50	100	200%
H- but no A-activity	H	0	0	0	0	4	26	56	14
H- and A-activity	H	9	17	21	35	17	1	0	0
	A	0	0	0	3	25	57	18	0

The results, summarized in the accompanying table, of the examination of a much larger series of individual stomach linings than were originally investigated[3] reveals, therefore, the presence of both A- and H-substances in some hog stomach mucoids, and thus confirms the conclusions reached by Bendich, Kabat and Bezer[8]. The amount of H-substance in those stomach preparations which show A-activity is, however, in most instances small (3–6 per cent) and is much less in amount than the H-substance in the mucoid material prepared similarly from stomach linings which show H-activity alone.

A similar serological analysis was made with the mucoid materials obtained by extracting finely divided pig stomach linings with dilute sodium carbonate (*p*H 9–10) for 36 hours at room temperature. The material was centrifuged to remove insoluble matter, cooled to 0° and acidified to *p*H 4·2. A precipitate formed. Precipitation was completed by the addition of five volumes of ethanol at − 18°. The yield of material from each lining was about 8 gm.

Although it is known that the serological characters of the blood-group mucoids are readily destroyed by treatment with alkali, it was considered of interest to determine the A- and H-character of the alkali-extracted material. The analysis showed that of 77 individual linings examined, 20 (26 per cent) showed H-activity alone, whereas the remainder showed A- and H-activity. The A-activities, in terms of the A-standard, were much lower than those observed with the acid-autolysed linings. Indeed, the majority of the activities found were equivalent to 6 per cent or less of the A-standard. Similarly, the H-activities of the preparations which showed no A-activity were low compared with those of the corresponding mucoids prepared by acid autolysis;

85 per cent of the preparations showed 25 per cent or less of the activity of the H-standard, whereas those preparations showing H-activity alone, prepared by acid autolysis, were all more active than this, and 70 per cent were equivalent to, or more active than, the standard H-substance.

The serological examination of the alkali-extracted material was not extended further; it is therefore not possible to determine to what extent the low group-activity of the preparations, compared with the acid-autolysed materials, is due to the incomplete extraction of the active substance from the stomach linings, to the destruction of the serological character by the alkali or to the heavier contamination of the preparations with unspecific materials.

Acknowledgment is made by two of us (D. W. C. and H. S.) to the Chief Scientist, Ministry of Supply, for permission to publish these results, and by another (E. F. A.) to the Medical Research Council for the award of a studentship for training in research methods.

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Antigens *C, D, E* in the Human Fœtus

During studies on the *C, D, E* blood factors, we have had the opportunity of determining these factors in a human fœtus of two months (weight 2·425 gm., length 38 mm.). Our investigations have demonstrated that it has the types, *A.N, c.D.e.* The blood of the mother was $A.N.\ \frac{C.D.e}{C\ -}$.

It is known that when the mother is $\frac{C}{C}$ (homozygous for *C*) the gene *C* is always transmitted to her child; but, in the present case, it was impossible to find this *C*-character in our fœtus of 60 days old. On the other hand, we can add that, at the third month of pregnancy, the *C, D, E* factors are all present and that the *D*-antigen is more developed than the others (personal observations).

We think that the early development of the *D*-antigen in the fœtus explains partially the more powerful and frequent immunization of the mothers against this *D* factor than against the *C* and *E* factors.

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Interference with Testosterone-induced Growth of the Seminal Vesicles and Coagulating Glands in Male Mice by a Folic Acid Antagonist

It has been established that adequate amounts of folic acid are necessary for the elicitation by œstrogens of the growth response of the female genital tract in the chick[1,2] and monkey[3]. Recently, it has been reported that folic acid antagonists markedly decreased the growth response to œstrogens of the genital tracts of the female chick[4,5], rodent[6] and frog[7].

In view of the fact that antagonists of folic acid interfered with hormone-induced growth in the females, it became of interest to investigate the effects of a folic acid antagonist upon the growth response to testosterone of the male sex accessories.

Three-month old mice of the *C* 57 black strain were castrated and divided into three groups, all being quartered in wooden cages of the type described by Bittner[8]. Group I served as control, and was fed a Purina chow diet supplemented with 10 gm. of succinylsulphathiazole (sulphasuxadine) per kilo (supplied by Dr. Lemuel D. Wright, of Sharp and Dohme). The animals in Group II received the control ration supplemented by 0·4 gm. of folic acid per kilo for 60 days (furnished by Dr. T. H. Jukes, Dr. A. L. Franklin and Dr. J. Williams, of Lederle Laboratories). At the conclusion of this period, this diet was discontinued and the basal ration supplemented with 100 gm. per kilo of a crude folic acid antagonist (mixture containing *X*-methylpteroylglutamic acid) was substituted. This regimen was continued for 45 days. Group III mice were maintained on a basal ration containing a supplement of 40 gm. of antagonist per kilo for 90 days. The antagonist-level was then raised to 60 gm. per kilo, and six days later to 100 gm. per kilo, and so kept for 10 days. During the final ten days of the experiment, each mouse in Groups II and III received a total of 8 mgm. of testosterone propionate (supplied by Dr. F. F. Yonkman and Dr. E. L. Mohr, of Ciba Pharmaceutical Products) in sesame oil administered intraperitoneally in eight 1-mgm. daily doses. A number of animals from the control group, Group I, were similarly treated with the male sex hormone, and an equal number were given equivalent amounts of sesame oil.

The seminal vesicles and coagulating glands of the testosterone-treated mice on the control stock ration exhibited the characteristic hypertrophy resulting from androgen treatment. The sesame oil elicited no visible growth changes. The animals in Groups II and III which were fed high levels of antagonist showed a reduced response to the androgen, and differed but slightly from the control stock animals to which sesame oil had been administered.

In other experiments *C* 57 male mice nurtured on diets containing up to 60 gm. of crude antagonist per kilo for periods up to sixty days did not show any significant reduction in their response to high dosages of testosterone, as manifested by the growth of the seminal vesicles and coagulating glands.

This apparent need for quantities of antagonist greater than those reported by Hertz[4] and Franklin *et al.*[5] may be attributed to the fact that the mice used here had free access to their excreta, which are extremely high in important nutritional factors.

The stimulating effects of androgens on prostate growth and function have been well summarized by

Huggins[10], who has further suggested that the androgen threshold of the prostate may decrease with old age. It has also been reported[11] that significant improvement often follows castration of patients with advanced cancer of the prostate. The preliminary data here presented appear to indicate that a vitamin antagonist can interfere with the stimulation of a target organ by testosterone, and so reduce the growth response of the male sex accessories to high doses of male sex hormone. These facts may point the way for the utilization of suitable anti-metabolites as a suitable control measure for prostatic hypertrophy. They are, therefore, offered at this stage so that they may be extended to other forms and further tested. Investigations involving chemically pure folic acid analogues and attempts at reversal with synthetic folic acid are in progress in our laboratories.

This investigation was aided by a grant from the National Cancer Institute, National Institute of Health, U.S. Public Health Service.

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Effect of Thiouracil and Uracil on the Germination of Cress Seeds

It has been found that cress seeds sown on a medium containing 2-thiouracil do not germinate normally. If the seeds are sown on a medium containing both thiouracil and uracil, or are pre-treated with uracil before sowing on thiouracil, germination is virtually normal.

Commercial cress seeds have been used in these experiments. They were sown on single layers of lint in Petri dishes, and incubated at 20–22° C. When the lint was soaked in distilled water, 80–95 per cent of the seeds germinated after seven days incubation. For the purposes of these experiments, germination was considered to have occurred if the cotyledons had expanded.

In a series of experiments, in which the lint was soaked in different concentrations of thiouracil, the results were as follows:

Concentration of thiouracil	No. of seeds sown	No. germinated	Per cent germinated
0·00001 *M*	40	32	80
0·00002 *M*	40	32	80
0·00005 *M*	40	19	48
0·0001 *M*	40	6	15
0·001 *M*	40	3	7·5
0·01 *M*	40	1	2·5

It will be seen that the inhibitory effect of thiouracil first appears at a concentration of 0·00005 *M*. In ten trials on separate occasions, the proportion germinating on 0·0001 *M* thiouracil has varied between 2·5 and 15 per cent. Even in the highest concentration the inhibition is not absolute. In most seeds the radicle is just visible after seven days on this concentration of thiouracil, but only occasional seeds progress any further.

Uracil by itself had no apparent effect on the germination of cress seeds at concentrations between 0·0001 and 0·01 *M*. But when seeds were sown on a suitable mixture of uracil and thiouracil, the inhibitory effect of the latter was greatly diminished. The results obtained with a fixed concentration of thiouracil, and varying concentrations of uracil, are shown below:

Concentration of thiouracil	Concentration of uracil	No. of seeds sown	No. germinated	Per cent germinated
0·0001 *M*	—	40	4	10
0·0001 *M*	0·00001 *M*	40	6	15
0·0001 *M*	0·0001 *M*	40	11	28
0·0001 *M*	0·001 *M*	40	27	67
0·0001 *M*	0·002 *M*	40	30	75
0·0001 *M*	0·01 *M*	40	30	75

It will be seen that uracil had to be present in a twenty times greater concentration in order to reverse the effect of thiouracil. Even then the proportion of seeds germinating was not quite so high as on control plates. The seedlings which germinated in the uracil–thiouracil mixture appeared quite normal.

Pre-treatment with a high concentration of uracil is even more effective in enabling seeds to germinate on thiouracil. When seeds were soaked for four hours in 0·01 *M* uracil, and then sown on 0·0001 *M* thiouracil, 82–85 per cent germinated. Successful germination took place even if the seeds were air-dried after the four hours soaking in uracil, and sown on thiouracil twenty-four hours later.

Uracil is known to be required for the growth of some bacteria[1,2] and fungi[3]. It would not be surprising if uracil (or a related pyrimidine) were also required for the germination of the seeds of higher plants. If this is so, then thiouracil might block the action of uracil by reason of the similarity of its molecular structure. This type of reaction was suggested by Strandskov and Wyss[4], who found that thiouracil inhibited the growth of *E. coli* and *L. casei*, and that the inhibition was reversed by equal or smaller concentrations of uracil.

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A Diffusible Substance in Irradiated Tissues?

In a series of experiments carried out on volunteers, a dose of X-rays was given to two small areas of skin separated by a varying width of untreated protected skin, and the reactions produced were significantly bigger than that over a single area of skin exposed to the same dose of radiation. When, however, the separation between the two paired areas was greater than

a certain minimum value, the reaction was equal to that of a single area at a symmetrical site. The separation value which cancelled this reciprocal vicinity effect was, for areas 1·56 cm. × 1·56 cm., approximately 2·5 cm. For areas 2·5 cm. × 2·5 cm. a separation of at least 3 cm., and for areas 3·5 cm. × 3·5 cm. a separation of more than 4·0 cm., was required to abolish the vicinity effect.

Measurements on an area of back scatter from an adjoining field excluded the possibility that these differences in reaction were due to an additional amount of radiation received by the paired squares. 'Perspex' sheets under the lead shield in which exposure windows were cut ensured uniform compression of the part of the body. Comparisons of degrees of reactions were made with control exposed areas in symmetrical sites in the same individual.

In a series of experiments reported previously[1], it was shown by means of various devices (sieve, annulus, etc.) that the severity of skin reaction to X-rays depends on the product dose-in-roentgens × area rather than dose alone. If an area is irradiated through a sieve, the reaction produced is approximately the same as would be produced if the whole area were given a much smaller dose; thus when a sieve was used having 11 per cent of its area transparent and 89 per cent opaque, the skin reaction produced was about what would be expected with a ten times smaller dose spread over the whole area.

It was stated that, the dose per unit area remaining unchanged, the reaction becomes a minimum when the normal tissues can exert their maximum protective role. In practice, this has proved to be the case in both X-ray and radium therapy. Introducing the perimeter/area and the shell area/volume ratios, a more comprehensive set of data are at hand when assessing the tolerable and optimal effective doses[2–4].

A possible explanation of the findings in these experiments may be the presence of a diffusible substance which is formed in the irradiated tissues. The quantity of this diffusible substance depends on the mean dose (to which dose × cm.^{2} is proportional). It diffuses so that the concentration attained is proportional to dose × sq. cm./length.

In the series of experiments of which a preliminary note is made here and which will be published in detail shortly elsewhere[5], it was found that 'length' over which the hypothetical substance diffuses is of the order of a few centimetres, and that for areas of 2·5 sq. cm. the substance diffuses approximately up to 2 cm., for areas of 6·25 sq. cm. it diffuses up to approximately 3 cm., and for areas of 12·5 sq. cm. it diffuses not less than 4·0 cm. away.

The diffusion constant of this substance is being studied following also some suggestions made by the late Dr. D. E. Lea, of Cambridge, whose widow has kindly forwarded to me a manuscript containing a critical review of my 1941 work.

The investigation is being carried out with the aid of a grant from the British Empire Cancer Campaign for technical assistance.

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A Saprophytic Liverwort

The plant which is the subject of Dr. S. Williams's interesting note, under the above title, in *Nature* of May 14, p. 769, is almost certainly *Cryptothallus mirabilis* v. Malmb. By a remarkable coincidence, on almost the same day as that on which this issue of *Nature* was received in the Library of this institution, there also reached us an issue of the Swedish periodical *Botaniska Notiser* (Lund), in which there appears an illustrated note on the occurrence of *C. mirabilis* in Sweden, Finland and (probably) Austria. The author, H. Sjörs, of the Institute of Plant Biology, University of Uppsala, summarizes the known occurrences of this hepatic, comments on its ecological associates, and gives a useful list of literature references, the more important and more accessible of which are here reproduced for the convenience of those who may not have easy access to the *Botaniska Notiser*.

We shall hope to hear more from Dr. Williams in due course regarding this noteworthy addition to the British bryophyte flora.

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A Simple Medium for Mounting Small Insects

The process of making permanent mounts of larvæ of various insects in Canada balsam is lengthy and often does not give satisfactory results, particularly of those covered with soft chitin. It involves complete dehydration and very careful handling. In the clearing medium, the specimens become very brittle and often lose important diagnostic hairs. For mounting mosquito larvæ, Wanamaker[1] has described a medium composed of creosote and Canada balsam; but with this medium preparations often get distorted and take a long time to dry.

A simple medium prepared by dissolving pine rosin in eucalyptus oil has given us very satisfactory results. Its refractive index (1·497) is lower than that of Canada balsam. The medium acts as a clearing as well as a mounting agent, and dries hard within three or four days. The insects can be mounted in this medium directly from 95 per cent alcohol after they have been in this dehydrating fluid for 15–20 minutes. They clear in about half an hour. It is preferable to prick the larvæ of mosquitoes in the thoracic region while they are in alcohol.

A detailed description of this medium will be published later.

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Successful Treatment of 'Scaly Leg' with 'Gammexane'

In a mixed flock of 147 poultry, 101 birds were infested with *Cnemidocoptes mutans*. Of these, sixteen were very severely affected. A series of preparations containing the gamma isomer of benzene hexachloride in dilutions of 0·1 and 0·5 per cent in various vehicles were used. Mild and moderate cases were freed from the infestation after one treatment, while after two treatments at an interval of a week only two birds continued to harbour living mites. The poultry houses were sprayed with benzene hexachloride in miscible oil, giving a deposit of 200 mgm. gamma isomer per sq. ft. A fuller account of the experiment will be published elsewhere.

We are indebted to Mr. J. S. Steward, of Imperial Chemical Industries, Ltd., for advice and the supply of the preparations used, and also to the staff of the University of Liverpool Veterinary Field Station for much valuable assistance.

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Problems of Organic Growth

In a recent article[1], Von Bertalanffy developed a complete theory relating growth to metabolism, sex, etc. The basic formula "which contains no hypothetical elements" on which the theory rests is given as

$$\frac{dy}{dt} = \eta y^n - \varkappa y^m,$$

with the explanation "In words: the change in body weight y is given by the difference between synthesis and destruction of building materials; according to general physiological experience, these processes will be proportional to some powers, n, m, respectively, of the body weight; η and $\varkappa$ are constants of anabolism and catabolism".

I should like to point out:

(1) Growth, increase of body weight, and increase of energy content are implicitly taken to be equivalent from a metabolic point of view. I recently stated[2] that a given increase in body weight may have widely different thermochemical meanings; an increase by 5 gm. of a very young animal (properly 'growth') represents approximately 1 gm. of protein and 4 gm. of water and mineral salts, or an energy content of 4–5 calories. An increase by 5 gm. of an older animal represents 5 gm. of fat or 45–50 calories.

(2) In fact, in an older animal, one can have an increase in the energy content of an animal, that is, a *caloric* difference between synthesis and destruction without concomitant increase in weight but due to replacement of protein tissue by fat depots.

Thus, even admitting that the rates of anabolism and catabolism can be taken as constantly proportional to a given power of the body weight, their difference would represent not the rate of increase of the body weight, but of the energy content of the organism. Outside of very early growth, these quantities are not equivalent.

I have also recently shown[3] that ageing—as opposed to growth—is characterized by a shift in direction from protein to fat synthesis, rather than by a drastic and sudden decrease at puberty of the efficiency of productive processes; this change of direction is to a certain extent reversible under special conditions, as under the influence of injections of growth pituitary hormone, malignant growth, etc. The "constants of anabolism and catabolism" are therefore meaningless in terms of body weight, although they may possibly retain a certain significance in terms of energy content of the body. Even in these terms, however, they are subject to variation if one or the other of the dietary essentials becomes a limiting factor[4].

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Production of Meson Showers

It was noticed long ago that the special type of interaction between the nucleons and the particles responsible for nuclear forces leads to the possibility of production of many such mesons in one single act[1,2]. This result has later been disputed, especially by Heitler and his co-workers[3], with the argument that the same interaction could possibly produce a strong damping effect as well, which might prevent any multiple production of particles. Jánossy[4] then put forward the view that some cascade process inside a nucleus may be responsible for showers consisting of several mesons. The recent admirable progress in photographic technique achieved by Powell and his group[5], however, has resulted in most beautiful pictures of the creation of many mesons (very probably π-mesons) in one single act. At the same time, the experiments on local penetrating showers show that these showers are produced in light material, probably also hydrogen, even more frequently than in heavy material[6]. Therefore it seems natural to analyse the recent experimental data with the help of the old theory.

This theory started from the assumption that in a very energetic collision of two nucleons a large part of the kinetic energy available in that frame of reference in which the centre of gravity is at rest ('c-system') will be turned over to the meson field. In the meson field a turbulent process will then go on, in which this energy is dissipated with the production of many mesons. The emission of these mesons should therefore be isotropic in the c-system for the same reasons that the distribution of small eddies in a turbulent motion is isotropic. Furthermore, it was suggested as a plausible assumption (ref. 1, equat. 38–40) that the mesons are produced in a spectrum of the type

$$dI = a dk_0/k_0, \qquad (1)$$

where k_0 is energy, k is wave number, $\varkappa$ is rest-mass of the mesons, dI/dk_0 is differential intensity ($\hbar = c = 1$). If the total energy available in the c-system is called ε, then the upper limit for k_0 is, roughly, $k_0 \sim \varepsilon$, and for the constant a one gets:

$$\varepsilon = a\int_{\varkappa}^{a} dk_0/k_0 = a\ln\varepsilon/\varkappa\,;\ a = \varepsilon/\ln\varepsilon/\varkappa\,; \qquad (2)$$

for the average number n of mesons:

$$n = a\int_{\varkappa}^{a} dk_0/k_0^2 \approx a/\varkappa = \varepsilon/\varkappa\ln\varepsilon/\varkappa. \qquad (3)$$

These results can now easily be transformed into the frame of reference in which the nucleus was at rest before the collision (r-system), and compared with the experiments.

If E is the energy, M the rest-mass of the primary nucleon, one gets:

$$\varepsilon = \sqrt{2M(M+E)} - 2M - \Delta\varepsilon, \qquad (4)$$

where $\Delta\varepsilon$ stands for the kinetic energy which (in the c-system) is left to the nucleons after collision, and which frequently may be rather small (of the order $\varkappa^2/M$). From (3) and (4) we conclude that the number of mesons varies roughly as the square root of the primary energy (comp. Wataghin, ref. 2). Assuming a primary proton spectrum of the form $dE/E^{2.7}$, which is cut off at an energy E_0 by the magnetic field of the earth, one gets as average value for ε:

$$\bar{\varepsilon} \approx 1{\cdot}42\sqrt{2M(M+E_0)} - 2M - \Delta\varepsilon. \qquad (5)$$

Since $M/\varkappa \approx 6{\cdot}5$ for the π-mesons, which are now known to be responsible for nuclear forces, one obtains for $E_0 = 5\,M$ (roughly corresponding to our latitude), and neglecting $\Delta\varepsilon$, the values $\varepsilon \approx 2{\cdot}9\,M$ and $n \approx 6$. If the symmetrical theory of nuclear forces is correct, on the average only two-thirds of the π-mesons should be charged and therefore visible. The frequency of showers with more than n mesons should decrease roughly as $(n\ln n)^{-2\cdot4}$.

If p is the momentum, p_0 the energy of the mesons in the r-system, ϑ and φ the angles in a polar co-ordinate system the axis of which coincides with the direction of the primary proton, one finds for the differential distribution of mesons (putting $1-\beta^2 = 2M/(M+E)$ and $\cos\vartheta = \zeta$)

$$dn = (a/4\pi)\,.\,d\zeta d\varphi dp_0 p(p_0 - \beta\zeta p)^{-2} \\ [p^2(1+\beta^2\zeta^2) + \beta^2\varkappa^2 - 2\beta p p_0\zeta]^{-1/2}. \qquad (6)$$

For comparison with experiment, one derives from (6)

$$\overline{\cos\vartheta} \approx 1 - 1{\cdot}74\,M/(M+E), \qquad (7)$$

which is valid for not too small values of $E(E \gg M)$. Equations 3, 4 and 7 give a connexion between $\overline{\cos\vartheta}$ and the number of mesons, which can be checked experimentally: $\overline{\cos\vartheta} \approx 1 - 8/n^2$ (for $n > 4$). Again it is to be remembered that the visible number of mesons may be only $2n/3$.

Integrating (6) over the angles, one gets for the energy spectrum of the π-mesons in the shower

$$dn = a\sqrt{1-\beta^2}/\varkappa^2\beta\,.\,dp_0\,. \\ \begin{cases} p_0 p(1-\beta^2)(p_0^2-\beta^2p^2)^{-1} \text{ for } p_0 \leqslant \varkappa/\sqrt{1-\beta^2} \\ \beta\varkappa^2(p_0^2-\beta^2p^2)^{-1} \text{ for } p_0 \geqslant \varkappa/\sqrt{1-\beta^2}. \end{cases} \qquad (8)$$

The maximum intensity lies at the value $p_0 = \varkappa/\sqrt{1-\beta^2}$, that is, for $E = 10\,M$, roughly, at 400 MeV. For a shower containing n mesons, the maximum should lie near $65\,n$ MeV.

So far the formulæ 1–8 refer to the collision of two nucleons only. When the collision takes place inside a nucleus, a considerable amount of energy and momentum may be transferred to the nucleus. The number of mesons may be increased above (3) by secondary processes, and their angular distribution will be broadened.

Assuming that the μ-mesons originate from the decay of π-mesons in the upper atmosphere, one gets for their energy distribution at high energies the spectrum $dn \sim dp_0\,.\,p_0^{-2\cdot7}/\ln(4{\cdot}3\,p_0/\varkappa)$. For the positive excess of all μ-mesons above energy p_0, one obtains, roughly,

$$(Mp_0/\varkappa^2)^{-1/2}\,.\,0{\cdot}14\,.\ln(0{\cdot}65\,Mp_0/\varkappa^2). \qquad (9)$$

Bernardini[7] has found that the positive excess decreases experimentally, roughly, as $p_0^{-1/2}$, in agreement with (9).

The special form (1) of the meson spectrum in ref. 1 was chosen not from purely theoretical reasons but to fit the experimental results. A theoretical discussion of this assumption will be necessary. The details of the calculations will appear in the *Zeitschrift für Physik*.

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Nuclear Magnetic Relaxation in Solids

Previous experiments[1,2] have shown that the relaxation time for the exchange of energy between the nuclear spin system in a solid and the thermal motions of the lattice is strongly influenced by the presence of paramagnetic impurities. In order to investigate this effect, we have made measurements of the relaxation time T_1 of the protons in the water of crystallization of mixed crystals containing a known concentration of paramagnetic ions. The measurements were made by the nuclear resonance absorption method[3,4] at a frequency of 9 Mc./sec.

The results obtained with crystals of potassium alum + chrome alum are shown in Table 1, and with magnesium potassium sulphate + copper potassium sulphate and magnesium potassium sulphate + ferrous potassium sulphate in Table 2.

The experimental error involved in some of the observations was considerable, especially at the higher temperatures, and the results can be considered to give only the order of magnitude of the relaxation

Table 1. Relaxation times (T_1 sec.) of $AlK(SO_4)_2\,12H_2O$ with and without added paramagnetic salt

Molar % of paramagnetic	T_1 at 90° K.	T_1 at 20° K.
0·0	1	300
0·1	1	80

Table 2. Relaxation times (T_1 sec.) of $MgK_2(SO_4)_2 6H_2O$ with various amounts of paramagnetic salt added

Molar % of paramagnetic	T_1 at 90° K.	T_1 at 20° K.	T_1 at 4·2° K.	T_1 at 1·3° K.
0·0	15	70		
0·02 Cu++	3	30	360	1000
0·1 Cu++	0·5	3		
1·0 Cu++	—	0·5	45	70
0·1 Fe+++	0·5	3		

time; there is, however, a clear indication of the dependence of T_1 on paramagnetic concentration and temperature.

The results for pure potassium alum at 90° K. appear to be anomalous, T_1 being exceptionally short and uninfluenced by addition of paramagnetic. This suggests that the relaxation process at this temperature is mainly due to some other mechanism. It is known that the alums undergo a transition at low temperatures[5], and it seems possible that, above the transition temperature, there is some freedom of rotation of the water molecules which would be effective in producing nuclear relaxation.

It is significant that in magnesium potassium sulphate the effects produced by cupric ions and by ferrous ions on the relaxation process seem to be identical, although these two ions almost certainly have very different electron spin lattice relaxation times.

An explanation of the effect of paramagnetic ions on the nuclear relaxation process can be obtained by supposing that the electron spin system of the paramagnetic acts as an intermediary between the nuclei and the lattice. The relaxation time is determined by the rate of transfer of energy from the nuclear spin system to the electron spin system. This transfer rate will, in general, depend both on the rate of conduction of energy through the nuclear spin system and on the rate of transfer from nuclei adjacent to a paramagnetic ion. With the concentrations of paramagnetic which we have employed, the latter process is likely to be the limiting factor. An attempt may be made to calculate the interaction between the nuclear spin system and the electron spin system from the magnitude of the magnetic field fluctuations arising from electron spin-spin interaction. The fluctuations may be assumed to be of a random character with a correlation time of the order of ρ', the electron spin-spin relaxation time. Application of the theory of Bloembergen *et al.*[4] leads to nuclear relaxation times which are of the right order of magnitude but are rather shorter than the observed times. Alternatively, one may attempt to calculate the rate of transfer of energy from the nuclear spin system to the electron spin system from a knowledge of the low-frequency absorption coefficient of the electron spin system. Unfortunately, in the presence of electric and magnetic fields, this absorption coefficient cannot be calculated, and experimental values have been obtained only for concentrated paramagnetic substances; it appears, however, that the electron spin absorption is of the correct order of magnitude to explain the observed nuclear relaxation times.

Note added in proof. It is possible that the electron spin absorption is less than we have assumed, owing to the effect of the external magnetic field, so that, over a certain region of temperature, T, it is mainly determined by the electron spin lattice relaxation time.

A further discussion will be given in a later publication.

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Hypersonic Velocity in Acetone at Low Temperatures

Frenkel[1] has given a critical discussion of the differences in behaviour between hypersonic and ultrasonic disturbances in liquids. Quoting Rao[2,3] and Raman and Venkateswaran[4], the statement is made that glycerine and carbon tetrachloride both yield higher velocities of propagation for hypersound than for ultrasound. In addition, the statement is also made that the velocity decreases in acetone from a value of 1,205 m./sec. for ultrasound to 978 m./sec. for hypersound ($v \sim 5 \times 10^8$). Venkateswaran[5] has made new measurements on acetone and carbon tetrachloride, making use of 180° scattering. As the result of these measurements, he finds excellent agreement between velocities determined by the hypersonic and ultrasonic methods for these two liquids.

There is additional evidence that acetone does not behave in the anomalous fashion mentioned above. In a paper by one of us[6], in which the emphasis was upon the polarization and intensity ratio of the Brillouin components, microphotometer curves are reproduced which show clearly that the hypersonic velocity could not possibly be as small as 978 m./sec. for acetone. (With the interferometer spacer used, the plus and minus Brillouin components would be separated by 0·35 orders of interference for a velocity of 978 m./sec.)

Venkateswaran[7] has shown that for hypersonic frequencies glycerine behaves essentially as a solid when the velocity measurements are made at temperatures where the viscosity is large. At high temperatures, however, the velocity approximates to that expected for a normal liquid.

We have made measurements of the hypersonic velocity in acetone at 30° C. and −78° C. Since acetone is a very mobile liquid throughout this entire temperature range, it is to be expected that the Brillouin components should remain sharp and the velocity of sound should obey the classical relationship $v = \sqrt{K/\rho}$ throughout this range of temperatures; K is the bulk modulus, ρ the density, and v the velocity of sound.

The measurements were made using λ 4078 and λ 4047 of mercury as the exciting wave-lengths. The spacers of the Fabry and Perot étalon were chosen so as to separate the plus and minus Brillouin components from each other and from the unmodified component by the maximum amount, that is, approximately 0·33 orders of interference. At 30° C. an 8·16-mm. spacer was used and at −78° C. the spacer was 5·95 mm. The angle of scattering was 90°. Results obtained are given in the accompanying

Hypersonic velocity in liquid acetone at different temperatures

Temp.	$\Delta\lambda$ (A.)/λ 4078	Angle of scattering	Hypersonic velocity (m./sec.)	Hypersonic frequency	Ultrasonic velocity (m./sec.)
*28° C.	0·0416	180°	1139 ± 25	$7{\cdot}61 \times 10^9$	1153*
30° C.	0·0296	90°	1126 ± 12	$5{\cdot}38 \times 10^9$	
−78° C.	0·0470	90°	1727 ± 30	$8{\cdot}62 \times 10^9$	1600 (calc.)

* Measurements by Venkateswaran, ref. 5.

table. Venkateswaran's[5] measurement is included for comparison purposes.

Unfortunately, there are no data available on the bulk modulus of acetone at low temperature; likewise, neither the velocity of sound nor the index of refraction has been determined for this liquid at these temperatures. We have used a value of 1·4254 for μ for acetone for λ 4078 at −78° C. which we have obtained from existing data making use of the relationship $(\mu - 1)/\rho$ = constant; ρ is the density. We feel that the value thus obtained may be somewhat in error, but certainly not enough to alter sensibly the velocity calculated from the wave-length measurements.

Westwater, Frantz and Hildebrand[9] have shown that the following relationship holds true within experimental error over a large range of temperature for a number of liquids:

$$\frac{1}{\rho^2}\, T \left(\frac{\partial p}{\partial T}\right)_v = \text{constant},$$

where ρ is the density, T and p are the absolute temperature and pressure respectively. The constant in this equation has been determined by Hildebrand[10] for acetone from data covering a temperature-range of 15–35° C. Hildebrand[10] has shown that for other liquids where the data are available this relationship holds true over the entire temperature-range investigated. We have obtained a value for $(\partial p/\partial T)_v$ at 195° K. by extrapolation of the above relationship.

Since complete experimental data are available for $(\partial v/\partial T)_p$, C_p, and the density as functions of the temperature, the adiabatic compressibility can be calculated from the usual thermodynamic relationships[11]. Thus the velocity of sound can be calculated in a perfectly straightforward manner. The measured and calculated values at −78° C. given in the accompanying table do not agree within the error of the measured velocity. However, the agreement is good enough considering the large extrapolation necessary, so that it is obvious that acetone behaves as a perfectly normal liquid with regard to the hypersonic velocity at the low temperature.

It was noted that on all the plates taken at −78° C., the intensity of modified and unmodified Brillouin components was equal, since the Doppler components were indistinguishable from the central component by means of their intensity. This fact yields an upper limit of 0·5 for $\gamma - 1$ as determined by the Landau–Placzek relationship. γ, the ratio of the specific heat at constant pressure to the specific heat at constant volume at −78° C., can be calculated in two different ways from existing experimental data: (1) from the ratio of the calculated values of the isothermal to the adiabatic compressibility; (2) from a well-known thermodynamic relationship[12] which yields $C_p - C_v$. Both these methods of calculation of γ involve the use of the extrapolated value of $(\partial p/\partial T)_v$ in a somewhat different fashion. Relationship (1) yields $\gamma = 1{\cdot}34$, whereas the second method gives 1·40. This discrepancy is, of course, not surprising in view of the large extrapolation involved. The salient fact of the intensity observations is that qualitatively the Landau–Placzek relationship is obeyed at −78° C., which is in agreement with earlier quantitative measurements[6] at room temperature.

This research was carried out on Contract *N6onr*-269, Task V of the Office of Naval Research.

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Negative Electric Fields in the Atmosphere

On a number of occasions during the past two years, we have observed a negative electric field (or potential gradient) in the atmosphere close to the earth's surface, when there has been very low stratus cloud (or 'high-hanging fog'). The importance of this result is that it must involve a process of separation of charge occurring in the cloud and giving a negative charge in the base of the cloud; evidence for a similar process in fogs comes from Scrase's[1] observations of negative currents to earth during some fogs. The conditions are very markedly different from those usually associated with the separation of charge, particularly in thunderstorms, and it seems that the theories, such as that of Simpson and Scrase[2], which have been put forward to account for thunderstorm electricity, are quite inadequate to account for the phenomenon here discussed.

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Structural Interpretation of Orientated Overgrowths in Crystallization

Minerals belonging to quite different species, for example, rutile and mica, often show definite geometrical associations. Experimental overgrowths of salts and other chemical compounds on crystalline matter such as gypsum cleavages have been investigated by a number of authors[1]. Consideration is generally given to superposition of the two lattices at the connexion surface of the two associated crystals[2]. Agreement between the lattice plane of

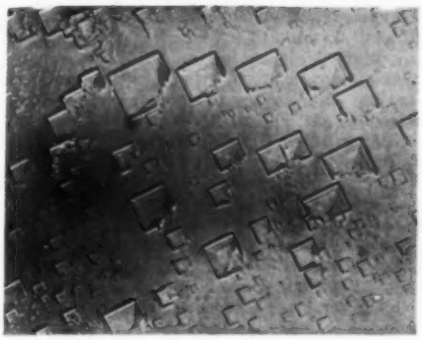

Fig. 1. Overgrowth potassium chloride/mica ((100)/(001)). (× 100.) Microphoto B. and G. Deicha

the deposit and the lattice plane of the substratum is not always satisfactory.

With structure data available for both substratum and deposit, it is possible to seek a less rigid interpretation. A new type of orientated overgrowth of alkali halides on mica will enable me to discuss this point briefly. I have already described, in recent French publications[3], the genetic conditions of this type of overgrowth; crystallographically it is characterized by parallelism and orientation of a face (100) of the cube of the halide upon a cleavage plane (001) of mica. A supersaturated potassium chloride solution crystallizing on muscovite provides perfect samples of this orientation. As shown in Fig. 1, it is possible to obtain whole areas of the mineral covered with parallel orientated crystals of the salt. The result is not altered by the position of the substratum and is observed on upper and lower faces of the lamellæ of muscovite under the microscope. Nucleation of potassium chloride crystals seems to occur at the actual surface of the mica.

Consider the pseudohexagonal layer potassium ions on the cleavage face of muscovite. This layer offers different possibilities for the attachment of the chloride ions. Fig. 2 shows schematically the location of chloride ions, which could provide a nucleus for further crystallization of potassium chloride, with a face of the cube orientated upon the cleavage plane of the sheet of mica. In this case diagonals of the potassium chloride cubes will be parallel to the rows [100] and [010] of muscovite.

Such interpretations suggest some alterations in the structures of the overgrowth. Such alterations can be traced and distortions are common in overgrown crystals. This is to be the subject of future studies in connexion with alterations of structures and distortions in twinning[4].

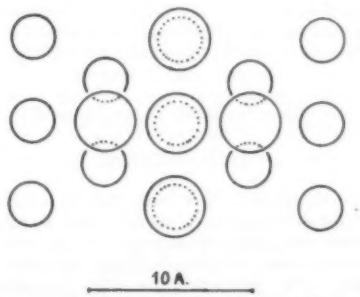

Fig. 2. A structural interpretation: K^+ ions (radius 1·33 A.), substratum. Cl^- ions (radius 1·81 A.), deposit nucleus

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Production of the Joshi Effect in Mercury Vapour

A PHOTO-DIMINUTION, Δi, of the discharge current i has been observed to be very pronounced chiefly in halogens[2]; this is attributed by Prof. Joshi[3,4] to the 'electron affinity' of the (excited) gas. Joshi has argued that the effect should also occur in metallic vapours, the 'electron affinity' of which is enhanced by excitation under electrical discharge. This prediction, confirmed strikingly by Joshi's results on metallic and other vapours[1,2,4], suggested the present investigation with mercury vapour.

The experimental arrangement consisted essentially of a Siemens's ozonizer excited by a transformer discharge; the former was evacuated completely except for the mercury vapour in its annular space. In agreement with Joshi's results[1,5,6,7], Δi was appreciable only above 'a threshold potential', V_m; this was 0·4 and 0·27 kV. (r.m.s.) respectively at 50- and 500-cycle frequencies of the A.C. supply. In one of the typical series of observations, the relative Joshi effect (per cent $\Delta i = 100\Delta i/i_{dark}$) was 36·5 per cent current decrease with light from a 200-watt glass bulb, at 2·7 kV. applied to the ozonizer; as this potential was decreased, the relative Joshi effect rose progressively to a maximum of 71 per cent at 0·54 kV., that is, near V_m, as generalized by Joshi[6]. The influence of an increase of the supply frequency is to reduce the relative Joshi effect; for example, from 69 to 27·5 at 1·1 kV. by changing from 50 to 500 cycles. The net Joshi effect, Δi, however, was larger at 500 cycles, due to the corresponding greater conductivity.

The influence of 'ageing' under electrical discharge of mercury vapour was remarkably similar to that of bromine[1]. At a constant potential with 50-cycle frequency, it showed in a short time a marked diminution in its electrical conductivity; this reached finally a stationary minimum. Cessation of the discharge for a short interval, followed by re-excitation at the original potential, restored the conductivity to the previous value; recovery was the more complete the longer the interval. The time of exposure to a discharge for producing the minimum steady conductivity and also the rest period necessary for restoring i to that at the original potential were greater the higher the exciting potential. Furthermore, the effect of prolonged 'ageing' was to reduce Δi. At 50-cycle frequency and a constant potential, an increase in temperature increased the conductivity; the corresponding Δi and relative Joshi effect, however, decreased. Thus, for example, at 1·9 kV., i_{dark}, Δi and relative Joshi effect were 1·58, 0·69 and 43·7 respectively at 22·5° C.; at 50° C. they were 2·10, 0·09 and 4·3 respectively. This is in accord with Joshi's mechanism[3,4] for the effect producing Δi.

In general, Δi and the corresponding relative Joshi effect increase on increasing the relative light-intensity. Thus, for example, as this was increased 256 times in a series of observations at 1·35 kV., the corresponding Δi and relative Joshi effect increased about 16 times, and in accord with previous results[8,9] observed in chlorine, tended to saturation for large intensities. This may well, therefore, be a general feature of this phenomenon[8].

When the wave-lengths are changed, Δi decreases in the following order: ultra-violet (2378–4248 A.) > unfiltered white (4000–8000 A.) > filtered blue (4240–4912 A.) > green (4912–5750 A.) > red light (6470–7000 A.). At low pressures, mercury vapour does not possess any absorption band but only two absorption lines (2537 and 1849 A.). The production of appreciable changes of current in the frequency regions mentioned above confirms, therefore, Joshi's deduction[1,9,10] that Δi is not entirely a consequence of an ordinary photon absorption by the atom or molecule, but some other quantal effect.

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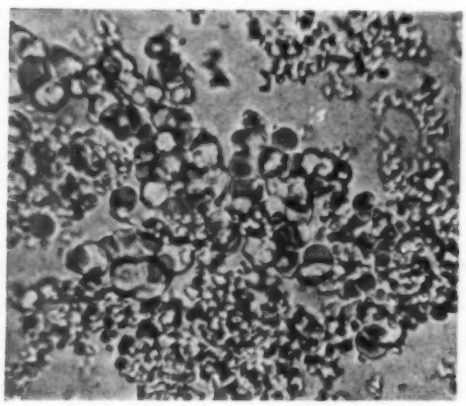
A New Crystalline Protein of the Myogen Group

Aqueous rabbit muscle extracts heated at 90° C. after addition of 0·05 volume N hydrochloric acid still contain proteins from which myokinase can be prepared[1,2]. These proteins can be concentrated by precipitation at 80 per cent saturation with ammonium sulphate and redissolved in water. Starting from that material we have succeeded in preparing a crystalline protein by using our method based on solubility curves at constant ionic strength and varying pH [3,4]. The accompanying photomicrograph gives an idea of the appearance of these crystals, which have a globular form.



The same crystals have also been prepared from an aqueous extract which was not subjected to heating in dilute hydrochloric acid. They appear in a fraction precipitating between 2·341 and 2·441 M ammonium sulphate (58·3 per cent and 60·7 per cent saturated at 22° C.), corresponding to a minimum of solubility at pH 6·07, indicated by our set of solubility curves previously described.

This new crystalline protein is thus the fourth species which we have crystallized from aqueous extracts by the use of our solubility data.

Aqueous extracts of dried muscle powder obtained after treatment of minced rabbit muscles with cold acetone have also yielded the same crystalline product in the same experimental conditions. This shows the unusual resistance of this protein to denaturation.

Chrobak and Baranowski[5] observed various kinds of crystals in preparations of myogen A. Our new crystals are possibly similar to one of these forms, as shown by the micrograph published by these authors (Fig. 1, p. 725, in their paper). In fact, myogen A bipyramids can be prepared from the fraction 2·008–2·341 M ammonium sulphate at pH 6·0 [1,2], while the crystals which we have now prepared are precipitated at pH 6·07 at a slightly higher concentration of ammonium sulphate. This would explain why some myogen A preparations, prepared by Baranowski at pH 5·9–6·0 from a fraction obtained between 45 and 65 per cent saturated ammonium sulphate, can give, on ageing (the ammonium sulphate concentration slowly increasing), different kinds of crystals.

Work is now in progress to investigate the possible enzymatic activity of this crystalline material.

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Surface Buffer Action of Alumina in Inorganic Chromatography

Several opinions have been expressed regarding the mechanism of inorganic chromatographic adsorption on activated alumina. Schwab[1] ascribes the cation adsorption to a permutite sodium ion/cation exchange produced by sodium ions which may be present in alumina as impurities. The adsorption of several cations as hydroxides or basic salts has been ascribed to the alkaline reaction of technical alumina. According to Jacobs and Tomkins[2], an exchange process, involving hydrogen ions or a hydrolytic adsorption, by a reaction of the type:

$$Cu^{2+} + H_2O \rightarrow Cu(OH)^+ + H^+$$

must be eliminated, since both lead to a considerable increase in acidity which has not been verified.

During my investigations I have noted that aluminium ions, displaced from alumina by the hydrogen ions produced by salt hydrolysis, are adsorbed near the top of the adsorbent. This behaviour explains why aluminium ions cannot be

found in the filtrate coming from an alumina chromatographic column. Alumina, binding hydrogen ions, shows a surface buffer action which, as a result, allows hydrolytic adsorption, according to reactions of the type :

$$6M^{3+} + 6H_2O \rightarrow 6M(OH)^{+} + 6H^{+}$$
$$6H^{+} + Al_2O_3 \rightarrow 2Al^{3+} + 3H_2O$$
$$2Al^{3+} + 4H_2O \rightarrow 2Al(OH)_2^{+} + 4H^{+}, \text{ etc.}$$

Alumina being in excess, the series of reactions continues until there is total buffering of the solutions and complete adsorption, as basic salts, of both the cation and the displaced aluminium ions.

Buffer capacity does not depend on the alkali which may be present in alumina. Thus I have found that hydrolytic adsorption, especially evident in the case of mercuric and thallic ions, the basic salts of which produce coloured bands, takes place also on pure alumina, which, produced from aluminium amalgams, is not basic. Pure alumina can also lower the activity of the hydrogen ions in the solutions of salts like cupric and nickel chlorides, etc., which have an acidic reaction on account of their hydrolysis.

This adsorptive capacity of sodium-free alumina confirms that sodium ion/cation exchange is not essential for chromatographic adsorption but accounts only for the excess adsorption of cations. The observed decrease[2] of adsorption on alumina with increasing acidity of the solutions can be explained in this way, since the increasing concentration of hydrogen ions causes the second reaction above to shift to the left.

The mechanism of the hydrolytic surface adsorption clearly results, according to my investigation, from the behaviour of a series of aquo-ions and cobaltamines. The ions with a lower coefficient of diffusion and dialysis and a greater hydration are the most adsorbed. Aquo-amine cobaltic cations precede amine cobaltic cations.

Ionic hydration is the essential factor in alumina adsorption. Since the co-ordination water molecules of the aquo-ions are polarized and oriented with hydrogen atoms outwards (because of the action of the electrostatic field of the cation), alumina exhibits a greater adsorptive capacity for water molecules of aquo-ions. Therefore the adsorption of aquo-ions bound to their water of hydration takes place.

It is well known that alumina has a polarizing action on surrounding water, the hydrogen atoms of which are attracted by the adsorbent. Since aquo-ions act as acids in the sense defined by Brönsted, because of the strong hydrogen repulsion of the co-ordination water, the ionization of hydrogen and the succeeding salt hydrolysis, on alumina, takes place more easily. Hydrogen ions thus liberated displace aluminium ions from alumina according to the scheme :

$$6[M(H_2O)_6]^{3+} + Al_2O_3 + 9H_2O \rightarrow 6[M(H_2O)_5(OH)]^{+} + 2[Al(H_2O)_6]^{3+}$$
$$2[Al(H_2O)_6]^{3+} + 2Al_2O_3 + 18H_2O \rightarrow 6[Al(H_2O)_4(OH)_2]^{+}.$$

The same is true for the aquo-amine cobaltic complexes. These, unlike the cobaltamine complexes, exhibit a well-defined tendency to produce hydrogen ions by the reaction :

$$[Co(NH_3)_5(H_2O)]^{3+} \rightarrow [Co(NH_3)_5(OH)]^{2+} + H^{+}.$$

Determinations of hydration heats on technical and pure alumina confirm that inorganic chromatographic adsorption is mainly based on the preferential adsorption for polarized water of aquo-ions. Technical alumina, which is much more active, shows a higher heat of hydration, that is, a greater tendency to hydrate itself.

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Temperature Inversion by Convective Cooling

MOST physicists are familiar with Prof. R. W. Wood's beautiful experiment[1] on the anomalous dispersion of sodium vapour. In the form in which the experiment is carried out by students in this Department, the sodium pellets are distributed evenly over about five inches in the middle part of a steel tube roughly twenty inches long and of diameter one inch, with a wall thickness slightly less than one-sixteenth of an inch. The tube is fitted with a side tube connected to a pump and a manometer, its ends being sealed off by a pair of spectacle lenses of suitable focal length. The horizontal slit is situated at the focus of the lens at the incidence end of the tube, and the vertical slit of the spectrometer is placed at the focus of the lens at the emergence end of the tube. It is best to work with a horizontal slit 1–2 mm. wide. Heating is carried out by means of six jets uniformly spaced 1 in. apart and about 0·1 in. in diameter, drilled along one side of a piece of brass tubing fed by gas and closed at the other end. The heater is arranged about 2 in. below the middle of the steel tube, and the gas supply is adjustable to give flame jets up to 3 in. high.

Four years ago I noticed that if the gas supply was suddenly shut off when the anomalous dispersion effect was showing clearly, the phenomenon disappeared fairly quickly until an undistorted continuous spectrum with superposed *D*-absorption lines remained, and then a mirror image of the anomalous effect about the normal axis of dispersion gradually developed, this inversion often being one-half to three-quarters the magnitude of the direct effect, and the whole transition taking place in an interval of *c.* 15 sec. More recently, through the kind co-operation of Messrs. J. Hampson and G. R. Mattocks, I have been able to re-examine this phenomenon of inversion in greater detail.

The inverse effect was only a small fraction of the direct effect when the flame tips had been about $\frac{3}{4}$ in. distant from the tube, but both the direct and inverse anomalous effects develop progressively as the flame size is increased. In both cases the maximum separation was achieved when the flames played lightly round the bottom of the steel tube, and under the most favourable conditions the inverse separation was found to be 70–80 per cent of the direct separation. With the flames licking well round the tube, the anomalous tails were of very poor definition, though well separated, and owing to intense absorption in the red and green, the trans-

mitted light was predominantly blue. Moreover, in this case, the inverse effect was less satisfactorily developed.

Even if we bear in mind the dependence of vapour pressure on temperature, we may conclude from these results that, after the removal of the flame, an inversion of the temperature gradient across the steel tube develops as a result of the good thermal blanketing of the upper side of the tube by the up-streaming hot gases, whereas the under-side of the tube cools more rapidly due to the in-streaming of cold air. The surprising thing is that, when the effect is at its best, the magnitude of the inverted temperature difference is comparable with that directly produced by the flames impinging on the under-side of the tube. At an intermediate stage the top and bottom of the tube have the same temperature, when the normal spectrum of the carbon arc is seen, with no trace of anomalous dispersion.

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Source-Rock of Lead Ores and the Age of the Granitic Layer

IT has been pointed out by Holmes[1] that most lead ores seem to have originated from a common source in which the products of radioactive decay of uranium have been accumulating continuously since time t_0 (3,350 million years ago). The ratio Pb/U of total lead to uranium-238 in this source-rock at the present time would be about 7·5, a value which seems to fit almost any kind of material, sialic, basaltic or meteoritic (excluding troilite and iron meteorites). Because of the special association of lead ores with granitic rocks, Holmes favours the view that the source-rock of these ores must be granitic in composition, so that t_0 would really be the age of the sial. Since Jeffreys has shown that solidification of the earth would probably require no more than 15,000 years, the age of this granitic layer would, according to Holmes, not be appreciably different from the age of the earth itself.

Recent data on the radioactivity of potassium-40 may throw additional light on these matters. Ahrens and Evans[2] have given estimates of the rate of heat generation (26×10^{-9} cal./year/gm. of total potassium) and of the total disintegration constant ($\lambda_\beta + \lambda_\varepsilon = 1{\cdot}55 \times 10^{-9}$/year) of potassium-40 which, although they remove most of the difficulties inherent to the earlier values suggested by Gleditsch and Grâf[3], still lead to remarkable conclusions. Adopting Ahrens and Evans's values, it is seen that the rate of heat generation from potassium alone, 3,350 m.y. ago, would have been about twenty times the present rate from all sources, in granitic material. If a granitic layer existed at that time, the thermal gradient in this layer must have been more than twenty times the present one, and the melting point of granite would have been reached at a depth of little more than one kilometre. Now a complete upward concentration of potassium and other radioactive elements is scarcely conceivable except as a result of crystallization, and could not very well have preceded it. Since Jeffreys[4] has shown that as long as the radioactive elements were uniformly distributed the rocks below a depth of 50 km. or so could never have solidified, it follows that at time t_0 the earth must have been entirely liquid except for a crust which was *not* granitic. The sial could not have formed at this early stage, and cannot, therefore, be the source of lead ores.

It appears probable that the sialic crust began to form only when the original amount of potassium-40 had been reduced sufficiently by radioactive decay to allow solidification of the mantle, and after the geothermal gradient in the crust had dropped to a value compatible with the crystallization of granite. This may explain why pegmatites, which probably never form near the surface where the gradient is greater than, say, 100°/km., are not older than 2,150 m.y. [5]. An alternative explanation may be that t_0 is not the age of the earth, but that of the material from which the earth was formed, a suggestion that Holmes has discarded[6] on the basis that the ratio Pb/U in the source-rock of lead ores does not fit that of 'average' earth material. This point may perhaps require further elaboration.

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Whitening of the Waters of the Dead Sea

REFERENCE to this somewhat rare phenomenon was made in *Nature* in 1944 [1], but no explanation was then given. A seismical explanation is now put forward.

Palestine in general is a seismic area, as has been shown by A. Sieberg[2], Bailey Willis[3] and others, and as may be discovered from the lists of epicentres in the International Seismological Summary. Moreover, it has been shown by geological surveying that faults in the neighbourhood of the Dead Sea exhibit recent movement, as do faults along considerable lengths of the Rift Valley. The region of Masada and Western Muhawat on the western shore of the Dead Sea appears to be particularly active seismically.

Earth tremors and earthquakes occurred in Palestine in 1943 during August (?), on September 6, 8 (?), 10, 28, and October 6. On September 10, 1943, an earthquake with epicentre near Jezreel caused a large part of the Dead Sea to lie within isoseismal 5 on the Rossi – Forel scale, and on that occasion the waters of the Dead Sea became turbid. The chalk which whitened the water was derived from the Lisan Zone. Sea abrasion assisted by earth tremors wears away the friable banks of the Lynch Channel, and earthquakes and water action stir up its shallow chalky bed.

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[2] Sieberg, A., *Medizinisch-Naturwiss. Ges. zu Jena, Denkschrift.en*, **18**, 2, Lief. 161 (1932).
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INSTITUTE FOR RESEARCH IN ULTRA-ACOUSTICS, ROME

THE "O. M. Corbino" Institute of the Italian National Council for Research (C.N.R.) has been newly constituted under its director, Prof. A. Giacomini, as an institute for research on ultrasonics and the applications of ultrasonics. After existing for a number of years as a laboratory for research in electro-acoustics[1], it has been decided by the National Council for Research, which is responsible for its maintenance, that there is sufficient work to do in pure and applied ultrasonics for the staff of about seven scientific workers to devote their time entirely to this subject. In making this change, the Institute becomes the first research organisation in the world to concentrate its activities entirely on ultrasonics (Fig. 1).

Photo: Vasari, Rome

Fig. 1. The Italian National Council for Research, Rome

At the moment, seven subjects are under study, and they are described as below.

The elastic constants of materials as determined by the resonance frequencies of small specimens both in flexural and longitudinal vibration. The specimen is held by thin wires and set into forced vibration by an electrostatic driver, located at the centre to produce the fundamental flexural mode, or near the end to excite longitudinal modes. The vibration amplitude is picked up by the same driving electrode, is connected to a frequency-modulated circuit and is measured either with an output voltmeter or with an oscilloscope. In the case of metals, especially at low temperatures, the plastic damping is so small that the presence of the ambient air exercises a comparable viscous drag, so that the specimen has to be placed in a near-vacuum.

Experiments have been carried out on aluminium to determine the effect on the elastic constants of the admixed metals in alloys and also of small cavities in the rod. Values for the velocity of propagation and of the sharpness of resonance in small billets of wood have been published. These cover a great variety of species and should be of value for all who make use of different kinds of wood in constructions. Of great interest, too, are measurements in some face-centred cubic metals (lead, aluminium, gold, silver) at liquid-helium temperature, which have shown a new relaxation effect produced by the motion of dislocations at a temperature of about 0·3 of the Debye temperature. On aluminium the largest known value of the selectivity Q, that is to say, 580,000, has been measured near the boiling point of helium.

Elastic constants of a thin plate from the resonant thickness. The ultrasonic beam comes through a thin window into a liquid (mercury), where it is more or less obstructed by the plate. The latter completely transmits the radiation when its thickness is equal to a half wavelength, the transmitted sound beam being shown by its ability to diffract a beam of light cast athwart the ultrasonic beam after it has emerged from the mercury into another (transparent) liquid.

Propagation constants of plates made of plastic materials. The plate is exposed to an ultrasonic beam in a liquid and turned from the square-on position until total internal reflexion of the longitudinal vibrations occurs, evidenced by the maximum intensity of the reflected beam, observed by an optical method. Regular reflexions of the ultrasonic beam from the second (internal) surface of the plate are avoided by proper shaping of these surfaces. If the plate is turned beyond this bearing, the reflected intensity decreases due to the transmission of flexural waves until it increases again as the angle of incidence approaches zero, or the value for total reflexion of transversal waves.

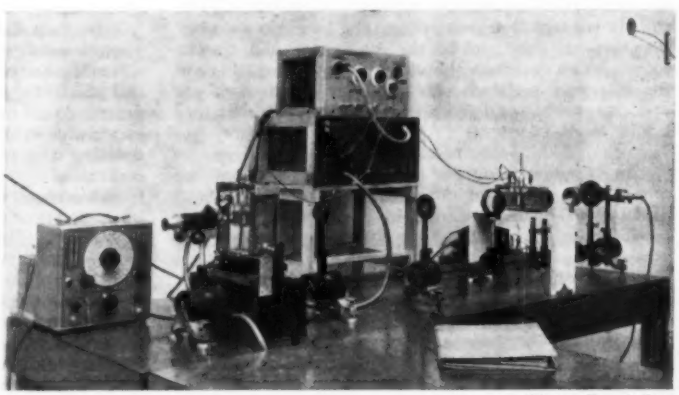

Photo: Vasari, Rome

Fig. 2. Apparatus for ultrasonic velocity measurements in liquids

Velocity of ultrasonics in liquids by an optical method. A form of optical stroboscope has been devised, using two sets of ultrasonic progressive waves passing through a transparent liquid in a small tank, from opposite directions, parallel but one behind the other. If a light beam crosses the glass tank at right angles to the two beams, it will be 'chopped' at double the frequency of the two sets of progressive waves. The light so interrupted can be used to illuminate another small tank containing the liquid under examination, which is itself irradiated at double the frequency of the primary sources by means of electrical coupling between this third quartz and the other two. In the light which passes the latter tank are seen dark bands at a separation equal to the ultrasonic wave-length in the experimental liquid. These spacings are measured by a microscope, and so the velocity in the liquid derived (Fig. 2).

Attenuation of ultrasonics in liquids. This apparatus likewise consists of an irradiated liquid crossed by a parallel beam of light from a mercury arc, the location of which along the ultrasonic beam can be varied. At each station, the intensity of the first-order diffracted light is measured with a photo-electric cell. It has been shown that the latter is directly proportional to the ultrasonic intensity at the place in question if the quartz source is not overdriven. From a set of such readings the attenuation along the ultrasonic beam is deduced. It has been found very necessary to watch the constancy of both light and sound sources if accurate results are to be obtained. One is assured by setting a photo-electric cell near the mercury arc, and the other by driving the quartz through a battery-operated dynamo-converter.

Properties of ultrasonic lenses made of 'Plexiglass'. The lenses are plano-concave, mounted at a distance from the quartz emitter or directly attached to it. The efficiency and properties of such lenses are being studied as a means of increasing the energy density locally of ultrasonics in a liquid.

Biological applications of ultrasonics. Oscillators of 800 kc./sec., 2 Mc./sec. and 4 Mc./sec. are used, immersed in a liquid carefully chosen to allow the maximum of intensity in the ultrasonic beam. This passes through a thin window—also chosen for its material and thickness so as to give maximum transmission—into the test tank which contains the bacterial culture. Experiments of this nature have, of course, been performed before, but many of them without proper control of ultrasonic intensity. In this work the temperature of the liquid containing the culture is carefully measured, as the bacteria are very sensitive to heat, while the holder of the quartz source is so designed that it is possible to calculate the intensity emitted into the liquid from its form and dimensions and from those of the windows and liquid media used.

The National Council for Research itself is an organisation which supports, and to a certain extent directs, scientific research in Italy out of funds provided by the Italian Government. The Administration Building (Fig. 1) opposite the University of Rome also houses the three Institutes directly under the control of the National Council, which is responsible for the salaries of their personnel. Besides the Institute for Ultra-acoustics, there is an Institute for the Applications of Calculus and the Institute for Nutritional Research. These three are in close relationship to the Science Faculty of the University of Rome. There is a library which, as far as scientific periodicals are concerned, is the best library in Italy. In recent years, this library has been helped by the British Council to make good some of its losses and gaps in British periodicals occasioned by the War. It admits accredited outside readers, for example, research students and fellows of universities, and maintains a micro-film service.

In addition to these maintained Institutes, the Council administers grants-in-aid to about seventy centres of scientific research within the Italian universities, providing funds for apparatus and post-graduate maintenance. Its scientific activities are governed by a number of committees of university professors under the general supervision of its president (Prof. G. Colonnetti) and secretary-general (Dr. A. Morelli). The organisation is, nevertheless, woefully lacking in funds and deserves more financial support from the Italian Government.

E. G. RICHARDSON

[1] *J. Acoust. Soc. Amer.*, **20**, 328 (1948).

ANNUAL CONFERENCE OF THE TEXTILE INSTITUTE

THE Annual Conference of the Textile Institute, which was held during May 24–27 in Dublin, met to discuss "The Industrial Application of New Knowledge". In an introductory paper, the chairman of the Conference Committee made clear the Institute's intention to discuss, not research as an activity, but the ways in which the textile industry transmitted and utilized new knowledge viewed as the end-product of research activity.

Nineteen papers were presented, made up of contributions from research associations, including the National Physical Laboratory, industrial research laboratories and development units, mill managements and a university department. It is in the nature of the textile industry, which is, in fact, many industries, that something of a miscellany should be provided by the titles. Thus an example of physical research immediately assimilable by the industry was provided in a paper on the acoustics of sound reduction; and the application of new knowledge to textile performance standards was illustrated by a paper on dimensional changes in socks. For all the six full sessions of the Conference, it was inevitable that the papers should, as indicated by these examples, spread somewhat thinly over a wide range of topics.

A pattern did, however, emerge, and the following general headings provide the outline: (*a*) lines of communication between sources of new knowledge and the factory; (*b*) winning of new knowledge from practical mill experimentation; (*c*) utilization of new knowledge in controlling the production of, and standardizing the performance of, consumer goods; (*d*) utilization of research findings from sources outside the textile industry; (*e*) transmission to other industries of new knowledge gained in the study of textile materials; (*f*) formal education of scientific workers required to fit them for research and its utilization.

This group of topics served to bring together directors, managers, technicians and research workers in discussion, such being the prime intention of the Conference organisers. There were collisions. A frequently recurring item of dispute concerned the difficulty experienced by management in understanding reports and papers written by scientific workers. The latter were accused of being needlessly obscure.

This discussion, which could have been foreseen, was surprisingly fruitful. It served to pin-point a vital weakness which now exists throughout the industry, namely, that in undertakings which, in a greater or lesser degree of urgency, require to assimilate new knowledge, there exists all too rarely the scientific man-power capable of applying it rapidly to existing techniques. Mill management cannot be expected to understand the language of the chemist, the physicist and the statistician. But if the output of research institutions is to be assimilated, there must be more widely employed the kind of worker who can understand the language of science and make constructive proposals for its translation into action, and also can assist mill management in formulating the right questions to ask of research. This latter function came out as an essential need; almost all textile operations are complex to a degree which calls for deep technical and scientific insight if questions about them are to be clearly formulated. All too often the wrong questions are asked.

The method of transmission of new ideas, from any source, to spinning room, weaving shed and dye-house is the core of the problem which was before the Conference. Three papers dealt directly with this. J. H. Black gave a detailed account of the way in which the British Cotton Industry Research Association is organised for transmission. He brought out the essential functions of a research association, showed its inner workings in a historical account of the Shirley Institute, and taught that the first of these functions was not research, but education. The more important work began after new knowledge had been acquired by the Institute. He estimated that about fifty per cent of the industry which subscribed to investigations supported by the Department of Scientific and Industrial Research were receiving what new knowledge was transmitted. This section of the industry applied transmitted ideas more or less directly; the rest received them slowly by a process of permeation. Mr. G. R. Perdue described the information service available to members of the British Launderers Research Association in similar terms. Mr. W. Howarth, a representative of mill managements, dealt with the handling of operatives, viewing any change in established mill technique as a human experience rather than as a mere mechanical point of departure. He made the interesting observation that 'intuitive' female workers were more receptive to new technical departures than the more 'logical' male operatives as a general rule.

Discussion of practical mill experiments touched on two major difficulties. In the small undertaking sufficient data under any given set of working conditions can rarely be amassed for useful statistical treatment. In the large undertaking, on the other hand, it is rarely possible to amass such data without expensive interferences with production. Many acute problems, especially in sizing, spinning and weaving, can only be approached by the statistical treatment of exhaustive observations. Further, in the institution of new techniques, there is often no pilot-plant stage; the card-room or the weaving shed must be its own pilot plant. Papers by E. Bradbury and H. Hacking, dealing with sizing and weaving, and by J. Ingham on worsted yarn manufacture, and the discussions which followed them revealed the dilemmas implicit in the above, and pointed to the importance of full co-operation of member firms in providing research associations with facilities for the highly co-ordinated field-work which mill experimentation calls for.

A lengthy and detailed account by R. A. McFarlane and C. C. Wilcock of the controls employed in the dyeing and finishing of rayon piece goods provided an example of a dyehouse management and a research department, in the same large organisation, working hand-in-glove to ensure efficient production to a predetermined standard of quality by integration, on the plant, of research findings with traditional practice. Other papers on control were: assessment of yarn quality (M. W. H. Townend), textile material specifications—their value, form and content (G. E. Collins), performance standards for development fabrics (C. P. Tattersfield) and shrinkage in knitted wool fabrics (W. A. Dutton). Discussion of these papers brought out some difficulties peculiar to the industry. To a great degree the textile industry of Great Britain and Ireland is made up of horizontal units. Spinners, weavers and dyers are separate concerns, often dealing with such other separate concerns as twisters, doublers, bleachers, raisers and finishers. In the vertical concern, steps for the control of production standards can be taken in the knowledge that there will be a corresponding standard of performance in the final product. In horizontally organised industry, a degree of enlightenment and co-operation is called for to attain this same end; but it does not exist. Even if it did, there is the converter. He, having bought a fabric, every element in the production of which may have been carefully controlled, is at perfect liberty to have it made up into garments or hangings for which it was never intended. Will our new knowledge reach out to the merchant converter, and by what means?

On the subject of new knowledge from outside the textile field, G. S. J. White dealt with textile contributions by the organic chemical industry. These he put forward under (*a*) polymers, especially fibre-forming chain-polymers, (*b*) colouring matters, (*c*) surface-active agents.

The dependence of textiles on the last two classes, which cover dyes, pigments, wetting agents, detergents, and a number of products for use in all wet processing, is well understood. The transmission of new knowledge based on organic research and manufacture has accompanied the sale and servicing of the product on one hand and, on the other, has flowed back to the makers from researches carried out by the more enlightened and better equipped of the users. All these are chemical products for use in processing fibres. What of fibres themselves? If these are to be made by the organic chemical industry, the textile industry must co-operate very closely indeed. Only they know what kind of fibres can fill any gaps that may exist in the gamut of natural fibres and rayons; only they can indicate what properties are required to make a usable textile from an organic chain polymer. Mr. White reproduced a table of properties for four synthetic chain polymers, Vinyon *N* (polymerized acrylonitrile and polyvinyl chloride), Orlon (acrylonitrile), nylon (a super polyamide) and terylene (experimental polyester yarn). These were properties measurable by physical and chemical means, such as colour, density, tenacity and resistance to reagents.

In synthesizing fibres of this type, the organic chemist must be advised by the textile man what combinations of physical and chemical properties are required for textile purposes. The organic chemist can understand and attempt to implement those requirements. But what of textile properties proper, such as drape, resilience, feel, dimensional stability? To integrate these needs into fibre research

calls for much more than product-servicing contacts between maker and user. The evaluation of any fibre in terms of these properties is a time-consuming process, calling for very close collaboration between all branches of the industry and for some refinement of existing experimental methods. If we understand it correctly, consideration of Mr. White's paper leads to the inevitable conclusion that the textile industry must dictate, in tempo and direction, the textile realization of the products submitted to them by the organic chemist. It is therefore important that, through its own research and development work, the textile industry should be in a position to exert the maximum critical pre-selection of organic chemicals proposed for use as textile fibres.

J. K. Berry described the contributions which rayons, especially high-tenacity regenerated celluloses, are making in engineering fields, and discussions brought out the value of collaboration with, for example, the rubber tyre industry. He is of the opinion that the expensive high twist required by tyre makers does not necessarily contribute to fatigue-resistance, and that there is a possible prejudice about the matter which can only be cleared up by co-operative investigation in both industries.

W. J. Hamburger, director of Fabrics Research Inc., Boston, U.S.A., presented a paper entitled "Industrial Applications of Stress-Strain Relationships". The contents were a sound engineering approach to fine-structure problems. But the author's remarks had to do more with the philosophy of research He described how a privately owned consulting laboratory not only can afford to have ideals in the prosecution of some fundamental research, but also, in his case, has been able to get industrial clients to pay for it and to discover that it paid them back.

The remaining papers were: the industrial application of sound reduction (N. Fleming); solubility number—a measure of cellulose degradation (D. A. Derrett-Smith); measuring the swelling of fibres in water (J. M. Preston and M. V. Nimkar); the development of a laundry washing process (F. C. Harwood and F. R. Hill); University departments—their influence on the efficient conduct and utilization of research (H. A. Turner). Messrs. Harwood and Hill revealed how, in the institution of a sound washing technique for laundries, new knowledge was slowly gained and, of necessity, only slowly superimposed on the rule-of-thumb methods of pre-Launderers Research Association days. Mr. Turner's paper was the one contribution to formal education of the scientific worker. The Conference was clear on the need for the type of scientific worker who could ensure the transmission of new knowledge to his employers. Mr. Turner considered the way in which he might best be trained, in a university department where technology was properly evaluated and research regarded as a training activity as well as an end in itself.

The Conference succeeded in revealing many of the obstacles in the way of maximum liaison between research activity and the application of new knowledge. If it were not always made clear how such could be removed, at least the problems involved were clarified, and it now remains for all concerned to contribute towards their solution. In this, through its *Transactions*, *Proceedings* and the organisation of specialized conferences, the Textile Institute itself has a unique opportunity of exercising leadership.

JOHN BOULTON

BACTERIAL OXIDATION OF ARSENITE

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IN 1918 H. H. Green[1] isolated from arsenical cattle-dipping fluids in South Africa a bacterium, provisionally referred to as *Bacillus arsenoxylans* but since lost[2], which was able to grow in culture media containing up to 1 per cent of As_2O_3 as arsenite and to bring about its oxidation to arsenate. In view of the well-known toxicity of tervalent arsenicals, now largely explicable in terms of their inhibitory action upon highly important sulphydryl-dependent metabolic enzymes[3,4], it is particularly unfortunate that Green's valuable paper, being published in an annual report mainly devoted to veterinary research, apparently escaped the attention of enzymologists and general bacteriologists; for the enzymic mechanism of arsenite oxidation was never studied while the strain was available, nor was the existence of arsenite-oxidizing bacteria ever afterwards reported.

However, during an investigation into spontaneous oxidation of arsenite in cattle-dipping fluids from Queensland, we readily isolated fifteen strains of heterotrophic bacteria which, like Green's bacterium, not only tolerate up to 0·1 *M* arsenite, but also bring about its oxidation to arsenate, and we have taken the opportunity to inquire into the mechanism of arsenite oxidation. These bacteria all appear to belong to the genus *Pseudomonas*; but five distinct types or possibly species can be recognized on the basis of colony characteristics, serological relationships, thermal tolerances, pigment production, utilization of carbon sources, and biochemical criteria. One type, found only once, resembles fairly closely the published description of *B. arsenoxydans*.

The enzymic mechanism has been studied mainly with the particularly active strain 17, belonging to Type 5. In most of the work reported here, arsenite oxidation has been estimated by iodometric titration; but in some studies which will be reported later, this has been supplemented and amplified by Warburg respirometry experiments.

Washed cells harvested from suitable liquid media, such as Koser's citrate containing 0·02 *M* sodium arsenite, actively catalyse the oxidation of arsenite to arsenate when aerated. Enzymic activity appears early during growth in arsenite media and is strongly adaptive; non-adapted cells are inactive and develop activity only after a lag-period in the presence of substrate. Activity of washed cells is not dependent upon a source of external phosphate, since it is identical in phosphate or collidine buffers at the same *p*H. The optimal *p*H lies between 6·0 and 6·7, at which arsenite is still almost completely undissociated ($pKa = 9{\cdot}12$), and this range is also optimal for growth and arsenite oxidation in arsenite-Koser medium. At the optimal *p*H, cells aerated optimally can oxidize about 90 μM arsenite per hour per mgm. dry weight. Oxidation is completely inhibited outside the range *p*H 3–11. Under the experimental conditions, the optimal temperature for oxidation by aerated cells in phosphate buffer is about 40° C.; the Q_{10} between 20° and 30° is 1·73, and Q_{10} between 30° and 40° is 1·43; and between 20° and 40°

Bělahrádek's temperature coefficient b is $1{\cdot}27 \pm 0{\cdot}08$. The critical thermal increment $\mu = 7{,}750 \pm 600$ cal., which may be compared with the corresponding values for the energy of activation, E, associated with inorganic catalytic arsenite oxidation: thus it may be calculated graphically from the data of Reinders and Vles[5] that with copper, $E = 12{,}400$ cal. between 15° and 35°, and with acid-washed 'Norit' charcoal, $E = 250$ cal. between 0° and 26° and 7,000 cal. between 26° and 35°. Arsenite oxidation is inhibited by cyanide (100 per cent by $0{\cdot}001$ M and 50 per cent by $0{\cdot}00003$ M) and by azide; and it is inhibited up to 50 per cent by carbon monoxide ($p\mathrm{CO} = 0{\cdot}95$) in the dark, the inhibition being partly reversed by light. These characteristics strongly suggest that cytochrome oxidase plays an essential part in arsenite oxidation. This is consistent with the destruction of arsenite-oxidizing activity by desiccation, acetone or toluene. Arsenite oxidation is not inhibited by urethane ($0{\cdot}1$ M) or by iodoacetate ($0{\cdot}01$ M at pH 5·3 or 6·4). It is, however, partly inhibited by fluoride (21 per cent by $0{\cdot}01$ M, 67 per cent by $0{\cdot}1$ M) and by pyrophosphate (16 per cent by $0{\cdot}02$ M), suggesting the participation of certain divalent metallic ions, although it is not inhibited by diethyldithiocarbamate ($0{\cdot}001$ M) or by α,α'-dipyridyl ($0{\cdot}001$ M).

By means of the anaerobic Thunberg technique, evidence is readily obtained that adapted cells, but not unadapted cells, contain an arsenite 'dehydrogenase'. By grinding cells with glass and submitting to a high gravitational field, the enzyme is obtained in a soluble form, together with traces of a substance (presumably bacterial cytochrome c) having an absorption maximum at $\lambda = 552$ mμ after reduction by dithionite. Unlike cell suspensions, this cell-free clear material has no measurable arsenite-oxidizing activity when aerated.

In order to demonstrate arsenite-dehydrogenase activity, it is necessary to use, as electron acceptors, redox indicators with E_0 values approximately higher than that of the arsenite–arsenate system itself (E_0' at pH 7·0 = + 0·077 V. to + 0·167 V., depending upon which of the several values for E_0 recorded in the literature is accepted). Suitable acceptors are indophenol-2 : 6-dichlorophenol, phenol blue, and m-carboxy-phenol-indo-2 : 6-dibromophenol (E_0' at pH 7·0 = + 0·217 V., + 0·224 V. and + 0·250 V. respectively). With indophenol-2 : 6-dichlorophenol, arsenite dehydrogenase has an optimum around pH 4·5.

The E_0 values are known for the mammalian cytochromes[6,7]; thus, at pH 7·0, E_0' for cytochrome $b = -0{\cdot}04$ V., for $c = + 0{\cdot}262$ V. and for $a = + 0{\cdot}29$ V. It is therefore clear that, unless the values for the corresponding bacterial cytochromes differ greatly from these, the cytochromes involved in bacterial oxidation of arsenite could include c as well as a, but could not include b. In this connexion it is significant that the soluble dehydrogenase preparation rapidly catalyses the reduction by arsenite of mammalian ferricytochrome c and also of any unreduced bacterial cytochrome c in the dehydrogenase preparation itself, the reactions occurring aerobically since ferrocytochrome c is not autoxidizable in air. The possibility that unrecognized electron-transporting mechanisms are required between arsenite dehydrogenase and cytochrome c cannot be excluded; but they would have to possess redox potentials intermediate between those of the arsenite–arsenate system and the ferri-ferrocytochrome c system, and therefore would not resemble any at present known to be concerned in cellular oxidations, with the possible exception of Slater's[8] 'factor', of unknown E_0, which operates between cytochromes b and c.

The mechanism of bacterial oxidation of arsenite therefore appears to comprise the coupling of an adaptive arsenite dehydrogenase system with the cytochrome system; the two electrons which are generated according to the standard oxidation-reduction equation

$$H_3AsO_3 + H_2O \rightleftharpoons H_3AsO_4 + 2H^+ + 2\varepsilon^-$$

are probably transferred through cytochrome c to cytochrome a and thence to atmospheric oxygen *via* cytochrome oxidase, water being regenerated with the aid of the associated two protons. There is no evidence that these bacteria can utilize the energy of oxidation of arsenite for growth either autotrophically or heterotrophically; indeed, the presence of $0{\cdot}02$ M arsenite in Koser's medium makes little difference to the growth-rate. It is therefore possible that the arsenite-oxidizing enzyme complex has been evolved as a protective mechanism.

The above investigation will be reported in greater detail elsewhere; meanwhile, a fuller investigation of the enzymic mechanism, including a study of the cell-free soluble arsenite dehydrogenase, is being continued.

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ROTHAMSTED EXPERIMENTAL STATION

REPORT FOR 1947

WHEN reading the annual report on Rothamsted Experimental Station for 1947, it is impossible not to be impressed by the ever-widening scope of agricultural research. When Rothamsted was founded, more than a century ago, most of the problems awaiting solution by the few agricultural scientists—mostly chemists—must have appeared within reasonable distance of solution. Indeed, the well-planned experiments laid down by Lawes and Gilbert soon brought results of inestimable value to farming at home and abroad. As work proceeded, however, deeper problems appeared on the horizon, and the limitations of many of the ordinary kinds of field experiments and routine analyses became obvious. Agriculture is the meeting ground of many sciences, and it became necessary not only to split it up into its component applied sciences, but also to enlist the aid of workers in pure science.

This volume includes fifteen departmental reports: chemistry, physics, microbiology, pedology, botany, crop physiology, statistics, plant pathology, biochemistry, entomology, bees, insecticides and fungicides, field experiments, the farms, and Woburn. The work at Rothamsted, as in the past, is directed

to soils and crops. It is concerned with most of the important aspects of fertility, and the production of high yields of crops and grass. It is only necessary to mention the Departments of Pathology and of Insecticides and Fungicides to indicate that, given a fertile soil, high yields are not necessarily assured.

It is impossible, in a review of this length, to give even a brief summary of the work in progress in each department, for the work of a single one may be very extensive. Thus, the Department of Chemistry includes: investigations on the manuring of beet and peas, and the use of bulky organic manures, etc.; fertilizer placement trials at various centres in Great Britain; a systematic study of the chemical changes in the soils from the long-continued cropping experiments at Rothamsted; the use of spectrographic analysis; the basic calcium phosphates in soil; manganese deficiencies; and the nutrition of forest nurseries. A wealth of information is contained in the reports, as well as a list of publications, together with abstracts.

Two special reviews are included. One deals with the work of the Department of Physics on the electric charges on soil particles. While it has long been known that water in contact with soil carries a positive electric charge, it is only through recent work in that Department that the net amount of charge on soil particles has been measured with reasonable precision over an extended range of *p*H. The phenomenon of base exchange has been studied in conjunction with such work, and one object of these physico-chemical studies has been to establish the nature of electric separation in the soil. Light is thrown on some aspects of the physical and chemical behaviour of soils. The fact that clay shrinks on drying, and swells when rewetted, must be due to the particles not being in solid contact, but separated by a water film. The author concludes that the exchangeable cations play a dominant part in maintaining these water films and in regulating their thickness.

The other special review deals with investigations begun in 1940 into the spread of potato virus diseases in the ware-growing areas of England. While the spread of these diseases had already been investigated in the seed-growing areas, little was known of the problem in the ware-growing districts of England, except that rapid degeneration of potato stocks occurs and that it is due to aphis-transmitted viruses causing leaf roll and rugose mosaic. Experiments were carried out in East Anglia to provide information on the activities of the aphides and the spread of viruses. Of the four species of aphides studied, the peach aphis proved of greatest importance. But though there was more disease in years of heavy infestation with this aphis, no simple quantitative relationship was established. The individual activities of the aphides appeared to be more important than their numbers. The effect of roguing and early lifting in controlling the diseases is discussed. The most important sources of virus infection were found to be infested plants within the crop, and the danger of volunteer plants left over from the previous crop is stressed. It was concluded that, though healthy seed could be grown on the English lowlands, it would call for such drastic roguing and early lifting as to be uneconomic. The most practical method of increasing the useful length of life of stocks appears to be further improvement in the health in seed-growing areas, so that few infected tubers find their way into the ware crops, which themselves should be grown on land free from volunteers.

The report on the field trials and on the farms contains much of interest to the practical agriculturist. The experiments on deep versus shallow cultivation would, no doubt, cause all farmers as well as gardeners to take sides. Those on the placement of fertilizers make it reasonable to hope for still better results from manures, as well as the possibility of using lighter dressings. The continued scarcity of feeding-stuffs adds interest to the grazing experiments carried out to measure the manurial value of cake fed on pasture; this trial is nearing the end of its third cycle.

The activities of Rothamsted are not confined to the British Isles, but have gradually extended to the Commonwealth and other countries. The report is, as before, replete with information of great interest to scientific workers, advisers, teachers, farmers and gardeners. At a time when there is a spate of publications of a technical and popular character dealing with the science and with the practice of farming, this annual report stands out as the most important publication of the year in the realms of soil fertility and the growing of crops.

BRITISH NON-FERROUS METALS RESEARCH ASSOCIATION

ANNUAL REPORT FOR 1948

THE twenty-ninth annual report of the British Non-Ferrous Metals Research Association was presented to its members at the annual general meeting held in London on June 28. The meeting was followed by the 'annual' luncheon, resumed for the first time since before the War, and a visit to the laboratories of the Association near Euston Station, where members saw the work in progress. The following notes cannot do more than indicate the wide range of problems being tackled by this Association and the type of equipment and methods that are being used.

The Association has expanded its activities and increased its scale of operations very considerably since 1945. One laboratory block, destroyed during the War, is now being rebuilt but will not be ready for occupation until the end of the year. In the meantime, however, two adjacent blocks of property have been taken over and adapted and occupied as laboratories. With the completion of the reconstruction and equipment of the original block, the Association's laboratories will provide adequately for the types of work which it at present carries out, including melting and casting on a substantial scale, and a new Metal Working Shop. This will permit the experimental manufacture of strip, bar and wire of materials required for test purposes.

It is clear from the annual report that the research work of the Association is planned with close regard to the needs of the sections of the industry represented in its extensive membership, and with close co-operation of those different sections in formulating policy. Internally, the Association's work is organised in sections dealing with subjects such as melting and casting, physics and mechanical testing, irrespective of the type of metal or alloy under investigation. This permits, at staff level, the closest integration of researches in similar fields dealing with different

basis metals. One of the great strengths of the Association is the opportunity which its structure provides of bringing metallurgical researches on widely different materials to a common basis, where the information obtained in one investigation can be applied with advantage in another. While the annual report describes the work in progress classified according to the particular sections of the industry interested in specific items, work in the laboratories is more easily described under the headings of the separate sections of the Research Department.

In the Melting and Casting Section, the accommodation of which is now being increased, some aspects of the metal/gas reactions causing unsoundness in castings, which have been studied intensively by the Association for many years, are still under investigation. The bulk of work at present, however, is concerned with fundamental investigations of (*a*) the mechanism of grain refinement in castings; and (*b*) the thermal gradients existing in castings during solidification and the effect thereon both of the metal or alloy itself and of the mould material.

The Mechanical Testing Section has now extensive equipment for the investigation of creep and fatigue of metals at room and elevated temperatures. The studies of creep resistance form a large part of the work of this Section, the programme ranging from lead and lead alloys (mainly at room temperature) to high-conductivity coppers at temperatures up to about 200° C., aluminium alloys, and more recently to copper alloys at temperatures up to 500° C. While much of this work has specific objects, various sections of the investigation are planned on fundamental lines, and the maximum opportunity is being taken for providing basic information on the mechanism of creep in these different materials.

A great deal of the work of the Physics Section is service work (particularly in spectrographic analysis and X-ray crystal analysis) for the other sections of the Research Department, but research is also in progress on the improvement of the spectrographic method, on the technique and utility of the electron microscope and on the fundamentals of soft-soldering operations. Researches in the Corrosion Section are mainly concerned with improving resistance to corrosion of copper, aluminium, zinc and their alloys by sea water and by domestic waters. Stress corrosion, particularly from the point of view of elucidating the fundamental mechanism of stress corrosion attack, is also being studied in aluminium and copper alloys. The General Metallurgy Section is dealing with a range of problems such as hot working, recrystallization and oxidation, and includes in its programme some exploratory investigations on the properties of titanium alloys at moderately high temperatures. Finally, a newly equipped Metal Finishing Section is now well under way with studies of the mechanism of adhesion of electrodeposits on aluminium and of the electropolishing of non-ferrous metals and alloys generally.

The annual report also includes paragraphs on the Information and Liaison Departments, lists of the reports issued during the year and of the officers, council and committees of the Association. It is interesting to note that more than two hundred representatives of industry co-operate through the various research committees and thus ensure that members of the staff are not without the support of that technological and practical experience which they themselves are necessarily in some cases lacking.

BRITISH BAKING INDUSTRIES RESEARCH ASSOCIATION

NEW RESEARCH STATION

IN June 1942, Mr. Alfred Bostock, then president of the National Association of Master Bakers, Confectioners and Caterers, launched an appeal to the baking industry for a foundation fund to be used to purchase and equip laboratories and test-bakeries and to provide other facilities for fundamental and *ad hoc* research into the problems of the industry. In June 1943, a trade conference, at which all sections of the baking industry were represented, set up a committee under the chairmanship of Prof. H. D. Kay, director of the National Institute for Research in Dairying. The committee entered into direct negotiation with the Department of Scientific and Industrial Research, and, with its guidance and help, the British Baking Industries Research Association was incorporated under the Companies Act on June 13, 1946. This committee acted as an interim council of the new Association until September 1946, when the first council was elected and began to enrol additional members. As soon as the Association was established as a legal entity, Prof. Kay relinquished the chairmanship, remaining an additional member of council, and Dr. R. T. Colgate was elected to succeed him.

On March 13, 1947, the council appointed Dr. J. B. M. Coppock as director of research, and he took up his duties on May 1 in that year. Later in the year, Chorleywood Lodge, a country house in Chorleywood, Herts, was bought, and its conversion to a research station began immediately. The equipping and staffing of the laboratories was carried out in stages, approximately six weeks being taken to equip each one. The first to be completed was the analytical laboratory, and immediately an advice service to members on the composition of raw materials became available. All possible accommodation in Chorleywood Lodge has now been converted, the last laboratory to be completed being the biochemical one. During the past eighteen months, fundamental research has been started on such problems as the cause and control of bread-staling, the physical properties of bread and biscuit doughs and cake batters, high-frequency baking and its potential applications, and many aspects of panary fermentation. Research reports which have been published include "Mineral Oils in Bread" and "The Determination of Extraneous Materials in Biscuits". Other publications sent to members include *Baking Abstracts*, published monthly in two sections, Science and General, and a bi-monthly *Bulletin*, which gives in semi-technical language interim results of work carried out at the Research Station, general surveys of advances in the science, technology and practice of baking, etc. Plans have now been approved for a new wing which will house a pilot-scale bakery, a nutrition laboratory and animal house and cereal laboratories.

The Research Station was formally opened by H.R.H. the Duchess of Kent on June 28. At this ceremony, the Lord President of the Council, Mr. Herbert Morrison, promised the continued financial support of the Department of Scientific and Industrial Research, provided that the industry also continues to play its part. At present, a grant of £9,500 in this financial year has been made by the

Department, as a result of the industry having contributed £18,500 in membership subscriptions.

During her tour of inspection after the opening ceremony, the Duchess of Kent, accompanied by Mr. Morrison, was shown displays of some of the work that is being carried out. The synthesis of chemically pure polyoxyethylene monostearate was demonstrated in the organic research laboratory. This substance has been marketed in an impure form in the United States and is under consideration in Britain as a 'crumb-softener'. The object of incorporating such a substance, as its name suggests, is to delay crumb-hardening, which is one of the most apparent manifestations of bread-staling. Its effect, when incorporated into a bread dough, was illustrated by loaves of various ages. It was pointed out that toxicological tests are also in progress, and members of the industry have been advised not to use polyoxyethylene monostearate or similar substances until considerably more information has been obtained on their possible physiological effects. The use of organo-silicon polymers to produce water-repellent surfaces on bread tins, to which dough will not adhere, the storage of biscuits under tropical conditions, the importance of personal hygiene and the ways in which salmonella and staphylococcal food-poisoning arise through carelessness on the part of operatives, were also illustrated.

FORTHCOMING EVENTS

Saturday, July 9

BRITISH PSYCHOLOGICAL SOCIETY, SOCIAL PSYCHOLOGY SECTION (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 3 p.m.—Annual General Meeting; Dr. Madeline Kerr: "Jamaican Folklore".

Wednesday, July 13

INSTITUTE OF WELDING (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 2.30 p.m.—Annual General Meeting.

Thursday, July 14—Saturday, July 16

PHYSICAL SOCIETY (in the Radiophysics Section of the Cavendish Laboratory, Cambridge).—Conference on "The Ionosphere and the Propagation of Radio Waves".

Friday, July 15—Saturday, July 16

BRITISH RHEOLOGISTS' CLUB (joint meeting with the MIDLAND CHEMISTS, at the University, Edgbaston, Birmingham).—Conference on "The Rheology of Thickened Liquids".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LECTURER IN THE DEPARTMENT OF INORGANIC AND PHYSICAL CHEMISTRY—The Registrar, The University, Liverpool (July 15).

LECTURER (Grade II) IN PHYSIOLOGY—The Secretary and Registrar, The University, Bristol (July 15).

LECTURER IN STATISTICS in the Department of Mathematics in the United College—The Secretary, The University, St. Andrews (July 15).

SENIOR ASSISTANTS (2) IN THE DEPARTMENT OF APPLIED CHEMISTRY, and a SENIOR ASSISTANT IN THE PHYSICS DEPARTMENT—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1 (July 16).

LECTURERS (3) IN MATHEMATICS for classes to General B.Sc. standard and/or Higher National Certificate in Engineering (Mechanical and Electrical), and a LECTURER IN PHYSICS to teach classes up to General B.Sc. standard—The Clerk to the Governors, Luton and South Bedfordshire College of Further Education, Education Office, Town Hall, Luton, Beds (July 16).

TESTING OFFICER and an EQUIPMENT ENGINEER, in the Dairy Engineering Department—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, Berks (July 16).

SCIENCE OFFICERS, to serve overseas or in specialist departments of the London headquarters—The Director, Personnel Department, British Council, 3 Hanover Street, London, W.1, endorsed 'Science Officer' (July 16).

LECTURER IN MATHEMATICS at the Coventry Technical College—The Director of Education, Council House, Coventry (July 16).

LECTURER IN THE DEPARTMENT OF BOTANY—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh 8 (July 16).

PHYSICIST to the Radiotherapy Department—The House Governor, St. Mary's Hospital, Paddington, London, W.2 (July 18).

SENIOR RESEARCH FELLOWSHIP for research into some aspects of University or Training College education—The Registrar, The University, Leeds 2 (July 18).

E.E.R. RECORDIST (female) IN THE DEPARTMENT OF APPLIED ELECTROPHYSIOLOGY—The Secretary, Institute of Psychiatry, Maudsley Hospital, Denmark Hill, London, S.E.5 (July 23).

CHAIR OF ECONOMICS in the University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (July 25).

ASSISTANT ADVISORY OFFICER IN AGRICULTURAL BOTANY, and an ASSISTANT ADVISORY OFFICER IN AGRICULTURAL ENTOMOLOGY—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh 8 (July 27).

I.C.I. FELLOWSHIP for research in Chemistry or Physics or a related subject at Durham or Newcastle—The Registrar, University Office, 46 North Bailey, Durham (July 30).

LECTURER IN AGRICULTURAL ECONOMICS, and a LECTURER IN AGRICULTURAL ZOOLOGY—The Secretary, The University, Aberdeen (July 30).

ASSISTANT LECTURER IN THE DEPARTMENT OF BOTANY—The Registrar, The University, Liverpool (July 30).

LECTURER IN CIVIL ENGINEERING in the subject of Fluid Mechanics and Hydraulics—The Head of the Department of Civil Engineering, City and Guilds College, South Kensington, London, S.W.7 (July 31).

GEOLOGIST in the Public Service, and FORESTERS (2) in the Forestry Department of the Department of Agriculture and Lands, Government of Southern Rhodesia—The Secretary to the High Commissioner for Southern Rhodesia, Rhodesia House, 429 Strand, London, W.C.2 (August 4).

GRADUATE BIOCHEMIST to teach Microbiology, Chemistry and Physics in relation to food—The Secretary, Smithfield College of Food Technology, Eagle Court, St. John's Lane, London, E.C.1 (August 6).

TEACHER OF SCIENCE (preferably a graduate in Physics or Chemistry)—The Secretary, L.C.C. London School of Printing, 61 Stamford Street, London, S.E.1 (August 13).

LECTURER IN INORGANIC AND PHYSICAL CHEMISTRY in the University of Western Australia—The Agent-General for Western Australia, Savoy House, 115–116 Strand, London, W.C.2 (August 22).

PROFESSOR OF PHYSICS, a LECTURER IN PSYCHOLOGY, a PROFESSOR OF FINE ARTS, and a LECTURER IN ECONOMIC HISTORY, at Rhodes University College, Grahamstown, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 31).

LECTURER IN TAXONOMY in the Department of Botany—The Secretary, University College, Gower Street, London, W.C.1 (September 10).

METALLURGISTS, PHYSICAL CHEMISTS and PHYSICISTS in investigator and research assistant posts, and a METALLURGIST in the Liaison Department for work in the application of research results to industrial practice—The Secretary, British Non-Ferrous Metals Research Association, 81–91 Euston Street, London, N.W.1.

RESEARCH BURSARY (tenable in the Department of Fuel Technology, The University, Sheffield) for research into fundamental or applied heat transfer in furnaces—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, endorsed 'Plant Engineering Division'.

LECTURER IN ELECTRICAL ENGINEERING, and a LECTURER IN PHYSICS—The Principal, North Staffordshire Technical College, Stoke-on-Trent.

SCIENTIFIC OFFICERS (Entomologists) in the International Red Locust Control Service, Abercorn, Northern Rhodesia—The Secretary, Anti-Locust Research Centre, British Museum (Natural History), Cromwell Road, London, S.W.7.

MEN interested in the technological application of fundamental research results on natural rubber and in the development of new processes—The Director of Research, British Rubber Producers' Research Association, 48 Tewin Road, Welwyn Garden City, Herts.

LECTURER IN THE DEPARTMENT OF MATHEMATICS—The Principal, Northampton Polytechnic, St. John Street, London, E.C.1.

ASSISTANT LECTURER IN CHEMISTRY, and a LECTURER (resident) IN AGRICULTURAL BACTERIOLOGY—The Bursar, Seale-Hayne Agricultural College, Newton Abbot, Devon.

OFFICER IN CHARGE, GENERAL AGRICULTURAL ANALYSIS SECTION of the East African Agriculture and Forestry Research Organisation—The Under-Secretary of State, Colonial Office, Research Department, Sanctuary Buildings, Great Smith Street, London, S.W.1.

SOIL PHYSICIST IN THE DEPARTMENT OF AGRICULTURE, Sierra Leone, for investigations in connexion with the reclamation, drainage and cultivation of paddy rice on very acid soil—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

ASSISTANT BACTERIOLOGIST—The Secretary, University College Hospital Medical School, University Street, London, W.C.1.

LECTURER IN MATHEMATICS, and a LECTURER IN CHEMISTRY—The Principal, Sir John Cass Technical Institute, Jewry Street, London, E.C.3.

PHYSICIST to undertake research work into dust sampling instruments and the physical properties of airborne dusts, especially in coal-mining—The Director, Pneumokoniosis Research Unit, Llandough Hospital, Penarth, Glam.

TECHNICAL ASSISTANT to be responsible for the physico-chemical research laboratories—The Head of the Chemistry Department, King's College, Strand, London, W.C.2.

SENIOR PHYSICIST to take charge of researches on the physical aspects of rubber science and technology, and a GRADUATE CHEMIST (woman) for abstracting and other work on technical literature—The Secretary, Research Association of British Rubber Manufacturers, 105 Lansdowne Road, Croydon, Surrey.